PORTFOLIO BEHAVIOUR OF SCHEDULED BANKS OF PAKISTAN

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ABSTRACT

This study has attempted to explain the portfolio behavior of the Pakistani Schedule banks and to provide the Pakistan monetary authorities with the best possible model through which they can influence the economy. First of all, we have investigated the links between monetary policy, the Banking Sector and the (aggregate) real economy in Pakistan over a forty year period, which commences in 1964. We have focused here to study how banks play a vital role in the monetary transmission mechanism through the banking credit channel. This study in chapter three provides the background for the two portfolio chapters where particular emphasis has given to the mean-variance form of expected utility and safety first Principle. Both static and dynamic versions of these models are examined. It is observed that these types of models, generally, perform well in terms of the traditional "goodness of fit" measures. Theoretical restriction on the properties of the demand/supply equations such as symmetry, homogeneity and joint homogeneity and symmetry were tested within each and every alternative model specification. For the estimation of the models, we used semi-annual balance sheet data of the State Bank of Pakistan for the period 1964:2-2005:1. Our main finding is that dynamic model performs better than static model in both expected utility model and safety first model and safety first dynamic model marginally perform better than expected utility dynamic model in terms of coefficients' significance of interest rates and general stock adjustments.

To my parents, wife and children

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TABLE OF CONTENTS

Chapter One: Introduction **1**

1.1: Introduction 1

Chapter Two: Banking Sector of Pakistan and Alternative Theories of Bank Portfolio Behaviour **6**

2.1: Introduction 6

2.2: Banking Background and Financial System of Pakistan 6

2.2.1: Commercial Banks and Their Functions 14

2.2.2: The Balance Sheet of Schedule Banks 15

2.3: Alternate Theories of Bank Portfolio Behavior 18

2.4: Nature of Data 23

2.4.1: Aggregation of Data 23

2.4.2: Endogeniety and Exogeniety of Banks' Liabilities 24

2.4.3: Endogeniety and Exogeniety of Banks' Assets 24

2.5: Descriptive Statistics of the Variables 32

Chapter Three: Monetary Transmission Mechanism and Long run Relationships between the Banking Sector's Balance Sheet and the Macroeconomy in Pakistan **34**

3.1: Introduction 34

3.2: Theoretical Overview of the Monetary Transmission Channel 35

3.3: MTMs: Econometric methodology: VARs, VECs and cointegrating relationships. 40

3.3.1: VARs 40

3.3.2: VECs and cointegrating relationships 45

3.4: Estimation of VARs: MTM, impulse response, variance decompositions and identified long run relationships 47

3.4.1: Variables, monetary policy indicators and the data. 47

3.4.2: Estimates of VARs and Identified Cointegrating Vectors 49

3.5: Innovations in the Monetary Policy Indicator Variables in the 2 Models and Innovations to Exogenous Monetary Policy Instruments. 66

3.6: Summary 71

Appendix A: Basic Data 73

Appendix B: The diagnostic statistics of the VARs for the 2 models 76

Appendix C: Tests for Cointegration 78

Appendix D: Kalman Filter results. 79

Chapter Four: Bank Portfolio Behavior under Risk Aversion: The Expected Utility Approach 80

4.1: Introduction 80

4.2: Theoretical Framework of Expected Utility Approach 81

4.2.1: Impact, Interim and Total Multipliers 91

4.3: Specification of the Models, Methodology and Data Analysis 93

4.3.1: Methodology, data and Their Properties 96

4.4: Discussion of Empirical Results 105

4.4.1: Return on the Interest Rates Matrix 109

4.4.2: Results on the Own Rates Effects 110

4.4.3: Results on the Cross-Rates Effects 111

4.4.4: Results on Non-Choice Assets 112

4.4.5: Results on the System's Dynamic Matrix 114

4.4.6: The Overall Evaluation of the Dynamic Model: Explanatory and Predictive Performance 117

4.4.7: Impact Effects of Exogenous Variables on the Banks' Portfolios 120

4.4.8: Interim Effects of Exogenous Variables on the Banks' Portfolios 125

4.4.9: Total Effects of Exogenous Variables on Banks' Portfolio 131

4.5: The Aggregation of Loans: A Comparison Between The Best Disaggregated and Aggregated Models 132

4.6: Summary 136

Appendix A 138

Chapter Five: The Principle of Safety First and Bank Behavior 140

5.1: Introduction 140

5.2: A Safety First Approach to Portfolio Behaviour 141

5.2.1: The Principle of Safety First and Commercial Bank Behaviour 144

5.2.2: The Bank's Portfolio Adjustment 152

5.3: Specification of Models, Methodology and Data Analysis 153

5.3.1: Methodology, Data and Their Properties 155

5.4: Discussion of Empirical Results 162

5.4.1: Return on the Interest Rates Matrix 165

5.4.2: Results on the Own Rates Effects 165

5.4.3: Results on the Cross-Rates Effects 165

5.4.4: Results on the System's Dynamic Matrix 170

5.4.5: The Overall Evaluation of the Dynamic Model: Explanatory and Predictive Performance 172

5.5: The Aggregation of Loans: A Comparison Between The Best Disaggregated and Aggregated Models 175

5.6: Summary: 178

Appendix A 180

Appendix B 183

Chapter Six: Conclusion and Comparison between Expected Utility And Principle of Safety first models 184

References 191

CHAPTER ONE

INTRODUCTION

1.1 Introduction:

The scheduled commercial banks of Pakistan have gradually grown since the partition of India and Pakistan 14 August 1947. Now they are more diverse than ever and play a very vital role in the country's economy. They offer a long range of financial services such as leasing, credit card banking, international finance and trade credit. This thesis is an attempt to explain the portfolio behavior of Pakistani scheduled commercial banks and to provide the Pakistani monetary authorities with the best possible model through which they can influence the economy. Therefore, a detailed knowledge of scheduled commercial banks' behavior is important in evaluating and enhancing the ability of monetary authorities to influence their behavior. The main focus has given to mean-variance form of expected utility maximization and safety first principle. We specify and test a number of static as well as dynamic models for the portfolio behavior of Pakistani banks. Theoretical restriction on the properties of the demand/supply equations such as symmetry, homogeneity and joint homogeneity and symmetry were tested within each and every alternative model specification. The semi-annual balance sheet data, for the period 1964:2- 2005:1, was used for the estimation of these models. For the estimation of the expected utility maximization approach and safety first paradigm, we have employed FIML (Full Information Maximum likelihood).

The reason for choosing this area of research is because the activities of the banking sector are crucial to the growth and development of Pakistan, which wants to evolve into a newly industrializing country, with an export-oriented economy which is increasingly diversifying into financial services. There is no considerable empirical/ econometric work done on Pakistan banks but what we have done is new in. It is an investigation that will throw new light at the SBP (State Bank of Pakistan) on the links between the Central Bank instruments of control and the impact of monetary policy on the banking sector.

As a background to our portfolio models, we have also investigated the links between monetary policy, the Banking Sector and the (aggregate) real economy in Pakistan over a forty year period, commencing in 1964. Those links have been articulated in many papers over those years, and several possible monetary channels have been advanced, some of which are essentially changes of name for existing channels, or nested within others, so that the main channels can be summarily defined to be: (1) the money or interest rate channel; (2) the bank lending (credit) channel, or "broad lending (credit) channel"; (3) the exchange rate channel; and (4) the expectations channel. The last two have featured in the literature over recent years due to the floating of exchange rates, foreign exchange crises, and the influence on markets and on the information/actions of Central Banks, of "the rational expectations" revolution. To examine the effects of a monetary policy shock on balance sheets and economic variables, we have employed as our econometric methodology standard semi-structural VARs, VECs and examine the existence of Cointegrating relationship.

The summary of our three empirical chapters are given below:

1. The State Bank of Pakistan considers treasury bills rate as its policy indicator and, therefore, we have used treasury bills' short term interest rate as an appropriate choice in the test VARs. In effect, the tighter monetary policy stance (such a reduction in the monetary base), which has produced an increase in the short term interest rate, makes a substantial contribution to the variation in output, but a correspondingly small impact on the variation in inflation. We have identified long–run cointegrating relationships between loans and deposits in both models, as these variables are considered to have the long-run influences on the banking sector. According to our model (1), the long-run relationships between the short-term interest rate, output, the price level and deposits are all positive. The second long-run relationship is between total bank loans, total deposits, the price level, aggregate output and the relatively riskless banking sector asset, government securities. All associations are positive. On the other hand, in model (2) the first relationship: "private sector" loans are positively related to total deposits and to GDP, and negatively associated with the rate of interest and the price level. From the second relationship, public sector loans, we note: the positive link with total deposits, GDP and also with government securities.

2. To investigate the portfolio behaviour of scheduled commercial banks of Pakistan, we have estimated various disaggregated expected utility static and dynamic models. We have chosen the best dynamic unrestricted model among all potential models to explain the banking portfolio of Pakistani commercial banks. We have also estimated various dynamic aggregated expected utility models in which we have aggregated all loans. The basic idea is to see if there is a loss of information in explaining the items in the portfolio, and hence the total portfolio, in aggregating all loans, implying that they are perfect substitutes for the banks. We have also compared the best expected utility disaggregated and aggregated models within the sample period and out of the sample period. The comparison shows that the disaggregated model wins over aggregated model.

3. For further investigation to the portfolio behaviour of commercial banks in Pakistan, we have estimated various disaggregated static and dynamic safety first models. We have chosen the best safety first dynamic model with symmetry restriction to explain the banking portfolio of Pakistan. We have also estimated various dynamic aggregated safety first and compared the best safety first disaggregated model within the sample period and out of the sample period. The comparison shows that the disaggregated model wins over aggregated model.

4. The best disaggregated safety first dynamic model marginally performs better than the best disaggregated expected utility dynamic model in terms of coefficients' significance of interest rates and general stock adjustments. Therefore, it can be said that the safety first model does explains better the portfolio behaviour of Pakistani Banks.

The rest of the thesis is organized as follows. Chapter 2 provides information on banking sector of Pakistan and literature review of portfolio behaviour of banks under risk aversion. Chapter 3 investigates money transmission mechanisms and explores long-run relationships between the Banking Sector's balance sheet and the macro economy in Pakistan. Chapter 4 describes the methodology of expected utility maximization and discusses the results, and provides impact, Interim and total multiplier affects. Chapter 5 is devoted to the safety first principle, explains the model, and provides the results for the portfolio behaviour of Pakistan banks and Section 6 provides conclusion and a comparative analysis of the empirical veracity of the two theoretic structures.

CHAPTER TWO

BANKING SECTOR OF PAKISTAN

2.1 Introduction:

In this chapter we provide background on the banking sector of Pakistan as a necessary prelude to the three research chapters of thesis.

The chapter is organized as follows. Section 2.2 discusses the banking sector and financial system of Pakistan. Section 2.3 outlines alternative theories of Bank Portfolio behaviuor. Section 2.4 provides detail of the balance sheet with time series graph including the interest rates. Section 2.5 provides the descriptive statistics of the variables that are going to be used in the estimation.

2.2. Banking Background and Financial System of Pakistan

The State Bank of Pakistan is the main monetary power of the country and it begun operating on 1st July1948. Prior to this, the Reserve Bank of India performed all the banking functions for Pakistan. As according to the Pakistan Monetary System and Reserve Bank order 1947, the Reserve Bank of India was authorized to work as a Central Bank of Pakistan up to 30th September 1948[1].

The important role, apart from the other responsibilities, of the State Bank of Pakistan is to make monetary policy that control the inflation through interest rate and exchange rate management where as these two channels (interest rate & exchange rate) is the most important part of the monetary transmission mechanism through

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[1] J.Russell Andrus (1958)," Economy of Pakistan"

which monetary policy actions affect inflation and output in economy. In interest rate channel, a rise (fall) in interest rate tends to decrease(increase) the aggregate demand that fall back (increase) inflationary pressures thus results in a tight (easy) monetary stance. On the other hand exchange rate channel directly affects the general price through changes in imported inputs and output prices and also indirectly affects through aggregate demand by changing in the pattern of spending in the economy. The effectiveness of exchange rate on inflation depends on many factors such as exchange rate pass-through, market structures, and elastic ties of imports, exports, consumption and investment with respect to exchange rate[2].

Pakistan has a well-developed banking system, which consists of 47 scheduled commercial banks, 6 DFIs (Development Finance Institutions), and 2 MFBs (Microfinance Banks).Our study for the portfolio behavior of banks is based on the scheduled commercial banks of Pakistan. All scheduled commercial banks in Pakistan are classified into three main groups. These are; public sector banks, domestic private banks and foreign banks. These public sector banks further divided into public sector commercial banks and specialized banks. These scheduled commercial banks are regulated by the State Bank of Pakistan's Prudential Regulations, albeit through different wings, and are subject to different SBP regulatory requirements such as capital and liquidity reserve requirements.

[2] SBP Working Paper Series------Zulifqar Hyder & Muhammad Mazhar Khan (2006)' "Monetary Conditions Index for Pakistan".

The financial sector[3] of Pakistan has developed in response to Government of Pakistan planning process that suppressed the growth and innovation, eliminated price, product and institutional competition, decreased supervision and enhanced the government ownership of the institutions within the sector. Due to this policy, financial sector of Pakistan has to bear the losses which have to be borne by the taxpayer and depositors.

The major player is the government in the financial sector of Pakistan who is controlling Nationalised Commercial Banks (NCBs) and Development Financial Institutions (DFIs) which account for more than 60 percent of all loans and around half of the sum of all deposits and government borrowing; government bonds that used for the deficit of the government .

There are two broad categories in the financial sector of Pakistan. These are banking companies and non- bank financial institutions and both of them are being controlled by the State Bank of Pakistan. Depending on the nature of institution, they are also regulated by the Corporate Law Authority, the Ministry of Finance and the Religious Board. We are briefly discussing below the description of these institutions.

Domestic commercial banks were nationalized in 1974 and from 1992; they have been in process of being privatized. Private banking sector is also playing vital role in the economy of Pakistan but national commercial banks (NCBs) are prominent in banking sector as they hold over 60 percent of all deposits. Due to inefficiency in national commercial banks (NCBs), the process of privatization has not been slowed

[3] Nadeem ul Haq (1997), Hanif (2002), Shamshad (2006), Qayyum (2007)

and interest rate spreads are large and deposit rates have been negative in real term quite frequently. Even interest rates spread are large, national commercial banks are incurring losses. On the other hand, foreign banks are operating successfully in the economy due to their superior management skills, better access to international financial markets and they are free from political influences. They have the lowest per unit cost of deposit and generate profit within the same economy.

Development financial institutions (DFIs) are mainly relied on government funding or lines of credit from multi-lateral agencies, guaranteed by government. These are providing long term debt and make a small percentage of the total financial asset. DFIs are marginalised due to limited availability of further financing and financial constraints. There are two large government organisations that provide mutual fund services in Pakistan. They remain large institutional investors on the equities market.

Debt market is based on government debt and commercial paper. There are two type of government paper are issued. These are federal govt bonds and several saving certificates. Federal government bonds are auctioned but government does not allow the market to completely determine the interest rate and saving certificates are issued at fixed interest. Many savings instruments and investment certificates are issued by the state-owned DFIs.

Equity market is very thin in Pakistan and only limited quantity of the potential firms are being traded and on other hand price jumps are quite common that leads to generate great volatility in the stock prices. Therefore, these stock prices do not reflect the true value of the shares. Due to poor credit practices, the accumulations of non-performing loans are increased with banks.

The foreign exchange market is being managed by the State Bank of Pakistan. From 1980 to onward, floating exchange system is operating in Pakistan. State bank of Pakistan is also providing forward market activity at a fixed non-market premium. All foreign exchange deposits in banks are surrendered to the State Bank of Pakistan and the foreign exposure of the SBP has become an important policy matter due to the rapid growth of foreign currency.

Insurance business has not developed properly due to nationalisation of life insurance in Pakistan.

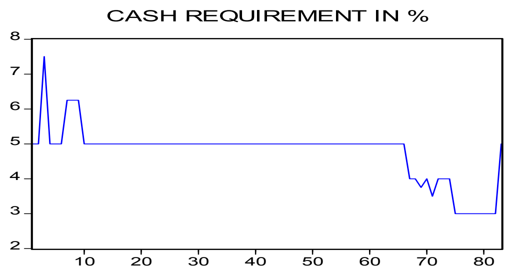
The Informal financial markets contain three type of financial activities; parallel currency market that intermediates in the pool of workers' remittances and illegal transactions, informal credit market provides system of granting credit within the stock market and trading with international future markets that is possible due to information technology and it is beyond any regulation and supervision.

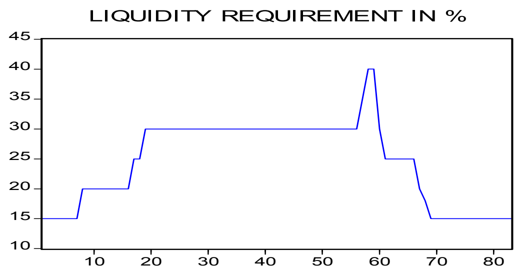
Two important steps have been taken by the monetary authorities of Pakistan in 1980s: first is to adopt floating exchange rate system and to give up fixed exchange rate mechanism, and second step is to start comprehensive financial sector reforms with the help of international financial agencies such as (International Monetary Fund and World Bank (Ahmed, 2006 and Khan and Khan, 2007). The objectives of these reforms were to modernize monetary sector and to utilize the market based instrument of monetary Policy in Pakistan. In 1995, monetary authorities have abandoned CRD (Credit Deposit Ratio)[4] and OMO (Open Market Operation) has become the only option for conducting monetary policy. As a result the State Bank of Pakistan can intervene in the secondary market to manage domestic liquidity by purchasing and selling government securities.

The major tools for SBP to contain monetary growth and manage market liquidity are CRR (Cash Reserve Requirement) and OMO, while the direction of monetary policy is indicated by changes in discount rate (Hyder and Khan, 2006). The Central Bank of Pakistan presently has made it mandatory to the scheduled banks to keep the balance

[4] Banking sector of Pakistan has gone through different credit regimes, Credit Ceilings Regime (1973-1992), Credit Deposit Ratio Regime (1992-1995), Indicative Credit Target Regime (1995-2001) and Market – Based Credit Regime (2001- Onward). Credit Ceilings and Indicative Credit Target regimes are more or less similar to each other where banks are advised to limit their credit up to certain level and if they are failed to do so, then, they have to pay penalty to the central bank. In Credit Deposit Ratio Regime, banks are directed by the State Bank of Pakistan to extend their credit to the private sector to a certain percentage of its deposits and that percentage was initially 30% for both local and foreign currency and thereafter, the percentage was changed accordingly. Last but not least, the Central Bank of Pakistan's credit policy was shifted to the Market-Based credit mechanism in 2001.SBP has liberalized the commercial banks to give credit to the private sector according to their own judgmental criteria but banks were advised to maintain prudential regulations (i.e, client specific and sector specific exposure, etc) and to strengthen their risk management framework(Janjua (2005)).

with the State Bank of Pakistan as a Cash Reserve requirement of 5% of Time and Demand Liabilities on weekly average basis, while minimum daily requirement is of 4%. Due to the legal requirement of maintaining Cash Reserve with SBP, State Bank of Pakistan does not give any profit/interest rate on cash reserves to the scheduled Banks. Further more, banks are obligated to maintain Liquidity Requirement 15 percent of Time and Demand Liabilities with them[5][6] .





From 1965 to 1997, banks had kept more liquidity (up to 60%) where as, legally requirement was from 18% to 40%. Actually banks made a secured investment during that time and enjoyed high returns, as there were high returns (from 8% to 16%) on securities i.e Government Bond and T Bills. But after banking reforms in 1997 to 2001, where the objectives of reforms were to support competitive environment and

[5] Liquid assets are defined as cash, gold or government securities. To maintain liquidity at all times ensure the State Bank of Pakistan that the funds deposited in the banks are not taken out the country, to any substantial extent (See J.Russell Andrus ,1958)

[6] Statutory Liquidity Reserve is governed under section 29 of the BCO, 1962. Presently it is being monitored at 20% of total demand and time liabilities of scheduled banks. This 20% is comprised of 5% on account of CRR (Cash Reserve Requirement) and 15% on account of Statutory Liquidity Requirement (State Bank of Pakistan).

complete the process of privatization and liberalization, the returns on securities cut down gradually from 12% to 1.5% and encouraged to the banks to issue more advances to generate their high returns[7].

The SBP has to give commercial banks of Pakistan so-called CAMELS rating, which is based on six areas assessed: capital adequacy, asset quality, management, earnings, liquidity, and sensitivity to market risk. With above information, SBP can enforce regulations by taking such formal actions as cease and desist orders to alter the bank's behaviour or may close a bank if its CAMELS rating are very low. These actions are taken to mitigate moral hazard by imposing restrictions to the banks from taking on too much risk. It does also help reducing adverse selection problem because with less opportunity for risk taking, risk-loving entrepreneur will be less likely to be attracted to the banking industry. Additionally, The Banking Companies Ordinance had been amended in 1997, which empowers the State Bank to prescribe capital requirements for banks. In exercise of these powers the State Bank has laid down Minimum Capital Requirements for banks based on Basle capital structure. The banks have to maintain a Capital Adequacy Ratio in a way that their capital and unencumbered general reserves are, at the minimum, 8% of their risk weighted assets, and effective from 1st January, 2003 banks are required to maintain a minimum paid up capital level of Rs.1

[7] SBP officials explained the behavior of liquidity and told the trend of keeping high ratio of liquidity has declined due to the decline in returns on securities in Market-Based Credit Regime (2001- Onward).

Billion. Now implementation of Basel II would also rationales the risk exposures vis – a viz. capital[8].

In continuation, both of these approaches has benefited the financial system in terms of improved stability and resilience, operating efficiencies and also attracted foreign investments in this area. A growing asset base, largely financed by the steady deposit flows signifies the increasing confidence of the depositors in the stability of the banking system. Improved asset quality involves improved risk management, credit appraisal and monitoring standards[9]. In the light of above restrictions under Basel 1, Bank has to change its portfolio behaviour according to the Basel 1 accord (minimum capital requirement and risk base capital requirement).

2.2.1: Commercial Banks and their Functions:

Scheduled commercial banks in Pakistan include nationalized, foreign and private banks. These banks are operating in accordance with the provision of the banking companies Ordinance, 1962. The legislators classified the functions of commercial banks in the light of the Ordinance[10].

- To develop resources which include accepting deposits in various types of account whether they are demand or time deposits.

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[8] see- the State Bank of Pakistan web site, Frederic S Mishkin(2003) and Saunders and Cornett(2006)

[9] See –State Bank of Pakistan web site.

[10] See An article written by National Bank of Pakistan (2008),” Banking in Pakistan”.

- To credit and investment operations. Credit operation means loans given to the clients of the bank on short and long term. On the other hand, under the investment operations the bank should invest in Government Bonds and, Treasury Bills.
- Ancillary operations that include collecting of cheques, handling of negotiable instruments, transfer of money from one place to another within or outside the country, opening of letter of credit, local or international, and leasing out the safe deposit lockers.
- Other banking operations i.e, accepting deposits, transaction relating to transfer of funds, various types of collections, etc.

Further, the banking operations can be classified into three main groups: commercial operations are, again, divided into several divisions, financial operations i.e, long or short term investment such as participation in industrial projects, issue of shares, debentures and other instruments of companies and service and commission operations i.e, Safekeeping and management operations, giving information access to the clients and developing a link between the stock exchanges and the customers for exchange operation.

2.2.2: The Balance Sheet of Scheduled Commercial Bank of Pakistan

Following is the balance sheet of scheduled banks of Pakistan.

2.2.1: Table the Scheduled Bank Balance Sheets

Assets	*Liabilities*
1.Cash	1.Capital
2.Advances	2.Reserve
3. Fed. Govt. Securities	3.Time Deposit
4.Treasury Bills	4.Demand Deposit
5.Provincial Govt. Securities	5.Borrowing from State Banks of Pakistan
6.Other Assets	6.Other Liabilities

A banking company is required the nominal or authorized capital to registered in Pakistan. That capital is further divided into paid up and subscribed capital. According to the Ordinance 1962, banking company can not carry out its business unless it satisfies the following conditions[11].

- The subscribed capital of company is not less than one half of the authorized capital and the paid capital is not less than one half of the subscribed capital.
- The capital of the company should consist of ordinary shares only.
- The voting right of the share holders should be strictly in proportion with share holders contributions to the paid up capital of the company.

Banking ordinance 1962 section 21 has made it obligatory for the every banking company incorporated in Pakistan to create a reserve fund. The reserve fund is the fund which is undivided trading profits set a side for contingencies and it is noted that the reserve fund for many banks in Pakistan has exceeded the paid-up capital.

Capital comprises of paid up capital of Pakistani banks. In case of foreign banks, it is equivalent rupee amount kept with the State Bank of Pakistan as reserve capital required to be maintained under the rules. Where as Reserves include all types of reserves maintained by the scheduled banks[12].

Ordinance 1962 section 29(1) has made it a legal obligation that every bank operating in Pakistan maintains liquid assets. The amount of the liquid assets should at least the

[11] See an article written by National Bank of Pakistan (2008),"Banking in Pakistan".

[12] See State Bank of Pakistan web site.

percentage of total demand and time deposit set by the State Bank of Pakistan from time to time. As discussed above, the current percentage of liquid assets (cash and liquidity requirement) set by the State Bank of Pakistan is 20 % of total deposits. These liquid assets should be consist of cash on-hand or cash in till, balances with the State bank of Pakistan and securities issued by Federal and Provincial Governments.

The data on deposit is collected and compiled on various dimensions. Deposit accounts are classified under five main type's i.e, current, call, other deposit accounts, saving and fixed deposit. The rate of interest is offered by the scheduled banks on various types of deposits like foreign currency accounts scheme, over five year maturity and unclaimed, over due or matured fixed deposits maintained under conventional banking. Rate of return on PLS deposits is, actually, the rate of profit given by the scheduled banks on various types of deposits such as call, saving, and fixed deposits. The rates are announced after the completion of the period of investment usually a half year based on.

In term of Advances are categories by borrowers. Borrowers are classified into government, public, private (business), trust, personal and other sectors. The rate of interest/return is the cost of using borrowed money by the borrowers expressed as a rate, or a percentage of the principal amount for a period of time usually a year.

The banks report their investment in securities with details of holdings of each type of securities. The holdings are classified by issuing institution of securities such as Federal Government securities, Provincial Government securities and Treasury bills.

We have also included dummy in our model in chapter four so as to see the structural break due to the effect of Islamisation process of the financial system in Pakistan that was started in 1979 when the specialized credit institutions in the public sector reoriented their financial activities towards non-interest bearing operations.

2.3: Alternative Theories of Bank Portfolio Behavior:

Many of theoretical and empirical work have been devoted to the portfolio behavior of banks in last four decades. The research has been stimulated by the need analyse the effects of alternative regulatory schemes, as well as by the desire to improve knowledge about the banking system as the most important link in the transmission process of monetary policy. Various approaches exist in the literature to formal study the portfolio behaviour of banks. These are the traditional approach, the precautionary approach and the portfolio theoretical approach[13].

Robinson (1962) analysis provides the traditional bank behavior approach. She points out the conflicting problem between profitability and safety and emphasizes that this problem should be resolved before investment of bank's funds, and she listed the steps to do so, to be taken sequentially. These are: Legal Reserve Requirement imposed by the Central Bank, Safe Investment, and Advances to customers and Investment in the open market for income generation.

[13] For details, please see Hester & Pierce (1975)," Bank Management and Portfolio Behavior", and also research work of Fan (1991), Subeniotis (1991) and Wibowo (2005).

Reserve requirement is a legal requirement for a bank imposed by the Central Bank of the country to enable banks to permit customers to withdraw demand deposits and time deposits upon demand. Consequently any bank before using funds, in any shape on form, should strictly follow the legal requirement of withdrawal of its deposits on demand by the customers. The cash holding for all possible and remote contingencies requires a bank to give up earnings needlessly. For such a dual purpose protective investment is regarded as the secondary priority. Thereafter, bank has to make loans to the potential customers for the business for which it is best fitted. By fulfilling legal requirement of reserve, protective investment, making loans to the customers, the funds available now can be invested in the open market for income generation. So, in above framework safety is the first priority and the interest rates do not affect the bank's choice of portfolio. Further, this framework does not indicate how a bank optimize when deciding whether or not to shift funds from one asset to another due to the total absence of marginal analysis which in turn arises from the exclusion of interest rates from influencing the choice variables.

Above models about traditional banking behavior are not analytical but descriptive. Chambers and Charnes (1961) improved upon this descriptive tradition by suggesting the application of a linear programming framework. They view the bank's problem as one of constrained profit maximization where the constraints are the "requirements laid down by the bank examiners which are interpreted as defining limits within which the level of risk associated with the return on portfolio is an acceptable" and the balance sheet constraint. In this model, interest rates can be introduced through the objective function --- the profit function. The advantage of such a model is that marginal analysis can be derived directly from the solutions to the constrained maximization problem. The reliability of the model is low (as uncertainty is absent from the model) by the assumption that the bank knows "the levels that will prevail, at various dates in the future, of demand and time deposits, of interest rates and of the bank's net worth".

Another theory of banking portfolio behaviour is the behaviour of bank under risk neutrality, Precautionary Approach that applied, first, by Orr and Mellor (1961) and Porter (1961). This theory is based on two basic assumptions: *(i)* The bank minimizes expected loss or maximizes expected return, and *(ii)* the bank is subject to random flows of deposits and knows (estimates) the probability distribution of deposit flows. Given the portfolio size the bank's problem is one of choosing the optimal beginning-of-period allocation of the funds among reserves and other assets to maximize expected profits. Many scholars have worked on this approach in later years {Morrison (1966), Pool (1968), Frost (1971), Baltensperger (1971a, 1972b, and 1980), Pringle (1974), Hester and Pierce (1975), Knobel (1977) and Sprenkle (1987)}.

In precautionary models, uncertainty plays a very important role but banks are nevertheless viewed as risk neutral. The popular portfolio theory is the theory of bank behavior under risk aversion upon which most of the empirical work based. This approach is originated from Hicks (1935) who first time introduced the idea of (μ, σ^2) mean- variance in his paper. The Hicksian idea were further developed by Markowitz's (1952, 1959) pioneering study of efficient portfolio selection and Tobin's (1958) paper on liquidity preference all making explicit allowance for risk aversion. The Portfolio Theoretical Approach predominating assumes that the bank maximizes expected utility, whose arguments are usually the expected value and variance of return of the portfolio, subject to the balance sheet constraint. The maximization of expected utility for a risk averse bank will in general result in the selection of a diversified portfolio. Prominent empirical work on commercial bank portfolio behaviour can be seen in Kane and Malkiel (1965), Perkin (1970), Parkin, Gray and Barrett (1970), Courakis (1974,1975,1980,1988), Klein (1971), Pyle(1971),Sharp (1974), White(1975), Bewley (1981),Hart and Jaffee (1974), Sealey (1980), Fan (1991), Subeniotis (1991), Arjoon (1994), Kagigi, Ford and Cadle (1994, 2001) and Wibowo (2005). In fact most of the empirical work on bank portfolio behavior is based on this approach.

Pyle (1971) worked on this model by using three assets i.e., riskless asset, advances and deposits. His objective was to determine the sufficient conditions for financial intermediation. He concludes that the expected return differential between assets and liabilities is positive then intermediation will hold for the stochastic independence between assets and liability returns. So, there is a positive risk premium on advances and a negative risk premium on deposits only then will intermediation exist.

Banks are considered as microeconomic firms that maximize an objective function operating within the framework of balance sheet constraints, authoritative control and market constraints. Banks have to perform simultaneously on different areas i.e, satisfying the depositors, attracting borrowers, maximizing their wealth and fulfilling their commitments to the Central Bank. It is noted that the study on the portfolio behavior of commercial banks started by the Edgeworth (1888). He points out the importance of random deposit flows that creates uncertainty for determining bank's optimal portfolio.

Both Pyle (1971) & Parkin *et al* (1970) totally ignored the liquidity problem in their models that could arise due to randomness of cash requirements and default risks. Kane and Malikiel (1965) have tackled this problem of deposit variation with modification of the Tobin and Markowitz portfolio model. They suggest that the variation of deposit be based on the relationship with the customers: it will decrease when the relationship is good and increase when it is the bad. Sealey (1980) tried to accommodate random deposit supply as one of the sources of the uncertainty for a bank. He has included random deposit supply in his model via an implicit supply function.

The portfolio-theoretical approach provides an explicit allowance for risk aversion that can arise either because bank's objective functions is convex in return or because influential depositors whose deposits are the major source of the bank's funds, or banking authorities induce it to act as a risk averter. It can handle constraints and supports the diversification.

The portfolio theoretical approach emphasizes the importance of uncertainty over future rates of return, uncertainty over future deposit withdrawals, hence uncertainty over future liquidation costs. Further, Bank takes care of expected profit and its variability in portfolio theoretical models and therefore, banks are considered to be risk averse and they maximize expected utility.

2.4: The Nature of the Data:

For the estimation of EU and SF models, we use semi-annual time series data (1964:2-2005:1). The major data sources State Bank of Pakistan and IMF. We provide below about the nature of the key endogenous and exogenous variables that will be used in our econometric work.

2.4.1: Aggregation of Data:

We assume that the scheduled banks behave identically and have the same expectations, the same return's variance-covariance matrix perceptions and identical utility functions. So, aggregation over decision units can easily accommodated on theoretical grounds by assuming that the group (all scheduled banks in Pakistan) itself is the decision taking-unit.

Following rules should be considered before taking aggregation over different assets and over elements of the assets. The aggregation items have to be homogeneous (Courakis, 1974, P.187); consequently, they must have the same return and risk characteristics so as not to be distinguished by the decision unit as different assets (Bailey, Driscoll and Ford, 1980, pp.7-8). However, it is observed that the previous research in portfolio behavior theory, different endogenous and exogenous variables employed in the estimation would themselves be composed of elements on which the aggregation principles may or may not apply. Realizing inconsistencies caused by such aggregation but simultaneously being deprived of alternative options as regard information and computational facilities, we have to employ the assumption that all such aggregated elements of banks are homogeneous (See Note 1 in Courakis(1974), p.185).

2.4.2: Endogeniety and Exogeneity of Bank's Liabilities:

It is observed in the literature that there is general understanding on whether the various deposits should be regarded as endogenous or exogenous variables. As Brainard and Tobin (1968, pp.102) have argued"…… banks must be willing to accept demand and time deposits at prevailing interest rate in at least as large volume as the public wishes to hold". Given the above, the status of the deposits seems to depend on the process of observed interest rate formation.

The State Bank of Pakistan generally, fixes interest rate. So, at the fix interest rate, Scheduled banks have to accept the certain volume of deposits demanded by the depositors. Therefore, we will take Demand Deposits and Time Deposits as exogenous variables.

It is well-established practice in the literature for treating ambiguous items as exogenous, Capital and Reserves will also be treated as exogenous (Parkin (1970)). Finally, the potential of borrowing of Commercial banks/ Schedule banks from the State Bank of Pakistan has to be treated endogenous variable since no valid regulation restricts this item.

2.4.3: Endogeniety and Exogeniety of Bank's Asset:

There is a general consensus developed in the literature about the treatment of liability items, but it does not carry over to consideration of the endogeneity or exogeniety of assets. The real nature of assets may depend on regulations of the monetary authority, SBP, valid from time to time. In our case, we have checked the data and found that credit ratios do not seem to have constrained on loans. Therefore, we treat all loans (Govt Sector, Public Sector, Private Sector, Personal Sector, Trust Sector and Other Sectors) as endogenous variables.

Continuation of asset classification, we would treat “Cash” as endogenous asset since its observed volumes are held irrespective of and above the reserve ratio regulation.
Our next step is to examine the status of treasury bills and government bonds. These items are presented as a separate account within the balance sheet but they are subject to the securities ratio regulation. The ratios change through the years and among different kinds of deposits but they always refers to treasury bills, Govt. Securites and Public enterprise. As discussed earlier, the scheduled banks have to keep some fraction of their assets in the form of cash, Treasury Bills or other approved securities. This constrain is called Liquidity Ratio 15% of Time and Demand Liabilities. Their main objectives to ensure that bank have sufficient funds in the form of liquid assets. In practice, it is observed that scheduled banks would be willing to invest in Treasury Bills and Federal Government Securities more than the required volume. They view these types of assets are “safer” and more “liquid” than loans. This is the indication that scheduled banks of Pakistan showing a high risk averse behaviour to all types of loans which have to be guaranteed by some form of collateral security. So, there is possibility that scheduled banks preferred investing in Tbills and FGS and in loans. Therefore, we treat Tbills, and FGS as endogenous variables. We consider PGS (provincial government securities) as an ambiguous item and treat it as an exogenous variable (as discussed above about the treatment of ambiguous items) as they have ceased to be issued by the State Bank in 1972 will mature in 2008. The classification of choice and non-choice assets is given table (2.2.2).Table (2.2.2) provides the

composition of each set of assets with the status of the liabilities and details of the notation for scalar variables and interest rates/returns.

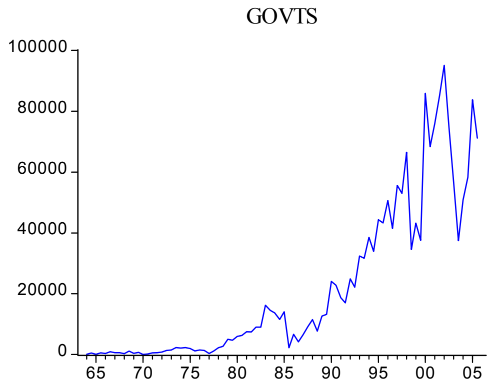
Table 2.2.2: Choice and Non-choice Assets of the Pakistani Banks

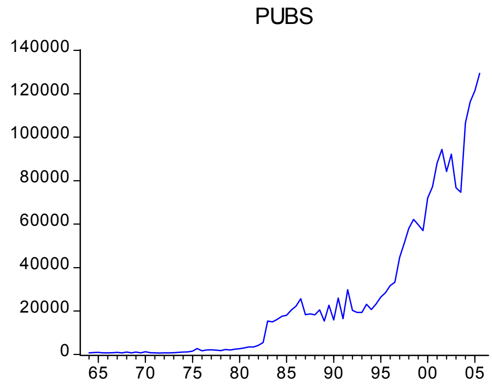
Notation	*Status*	*Description*
Panel A : Balance Sheet		
Assets		
GOVTS	*Endogenous*	*Loans to the Govt.Sector*
PUBS	*Endogenous*	*Loans to the Public Sector*
PRIVS	*Endogenous*	*Loans to the Private Sector*
PERS	*Endogenous*	*Loans to the Personal Sector*
OTHERS	*Endogenous*	*Loans to the Others Sector*
TRUST	*Endogenous*	*Loans to the Trust Funds & Non-Profit Org.*
PGS	*Exogenous*	*Provincial Govt. Securities*
SUMB	*Endogenous*	*Borrowing from, SBP*
FGS	*Endogenous*	*Federal Govt. Securities (Bonds)*
TBILLS	*Endogenous*	*Treasury Bills*
CASH	*Endogenous*	*Cash*
Liabilities		
CAPITAL	*Exogenous*	*Capital*
RESERVE	*Exogenous*	*Reserve*
CAPRES	*Exogenous*	*Capital & Reserve*
TTD	*Exogenous*	*Total Time Deposit*
TDD	*Exogenous*	*Total Demand deposits*
TDTL	*Exogenous*	*Total Demand and Time Deposit*
Panel B: Rates of Return on the Asset		
WAG	*Exogenous*	*Warra (weighted average rate of return) Govt. Sector*
WAP	*Exogenous*	*Warra Public Sector*
WAPR	*Exogenous*	*Warra Private Sector*
WAPL	*Exogenous*	*Warra Personal Sector*
WAOTH	*Exogenous*	*Warra Other Sector*
WAT	*Exogenous*	*Warra Trust Funds & Non-Profit Org.*
PGR	*Exogenous*	*Provincial Govt. Securities Rates*
CMR	*Exogenous*	*Call Money Rates—proxy for discount rates*
GBYLD	*Exogenous*	*Govt. Bond Yield*
SIXMTBR	*Exogenous*	*Six Month Treasury Bills Rates*
INFLN	*Exogenous*	*Inflation (Consumer Price Index)*

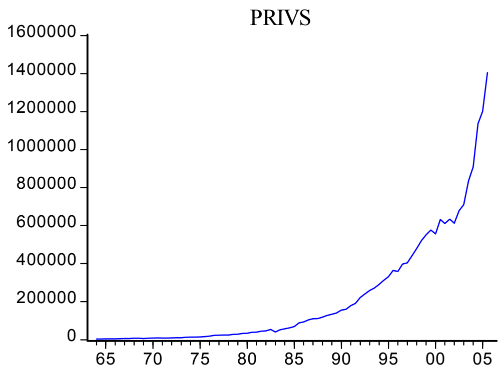
The graphic presentation of data for (19964:2-2005:1) endogenous and exogenous variables with weighted average rate of interest is given below.

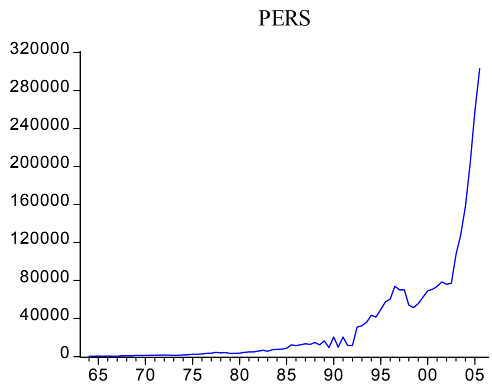
2A: Graphic presentation of data for endogenous and exogenous variables:

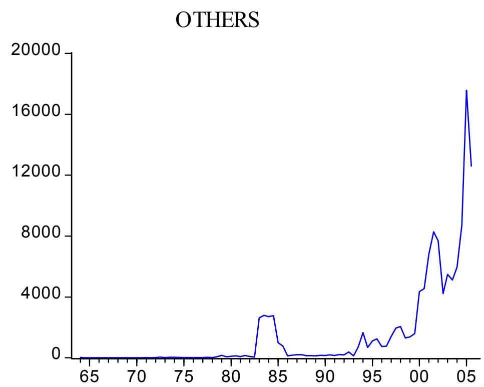
(2A.1): Endogenous variable (Rupees in Millions):



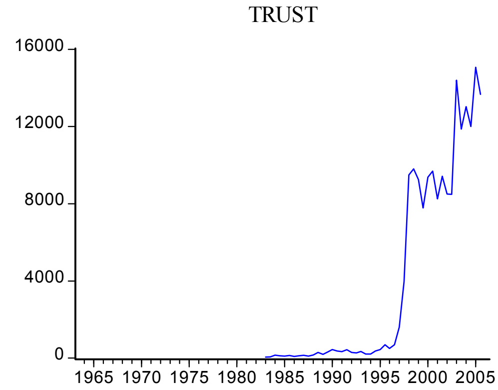


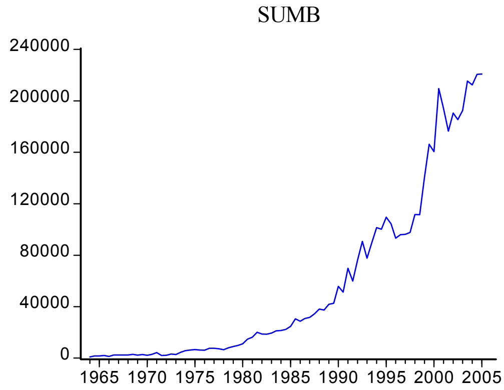


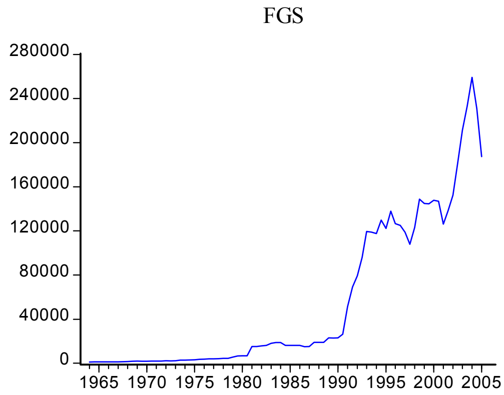


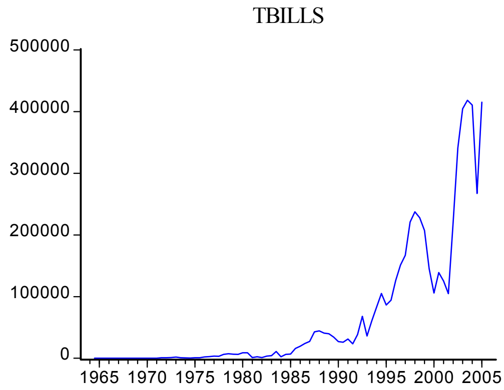


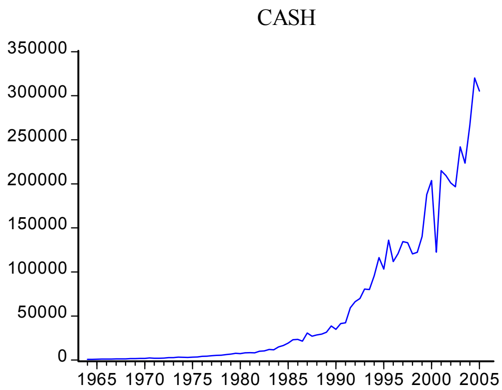
Endogenous variable (Rupees in Millions): Continued



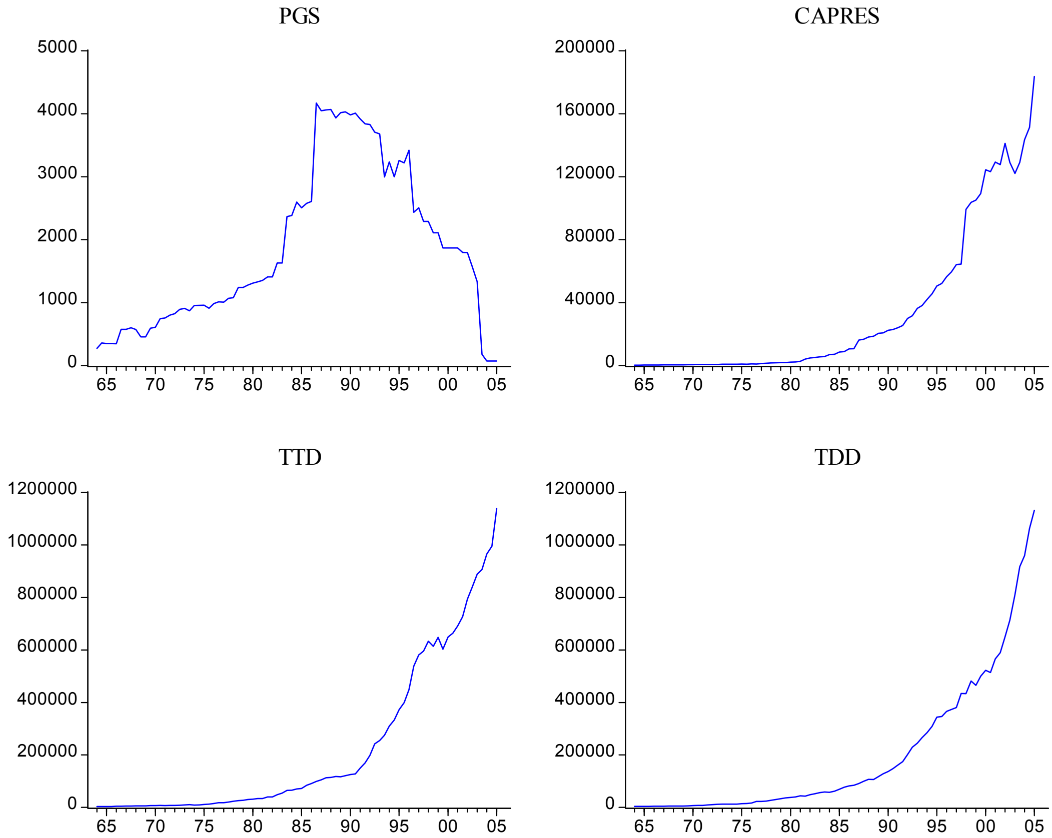




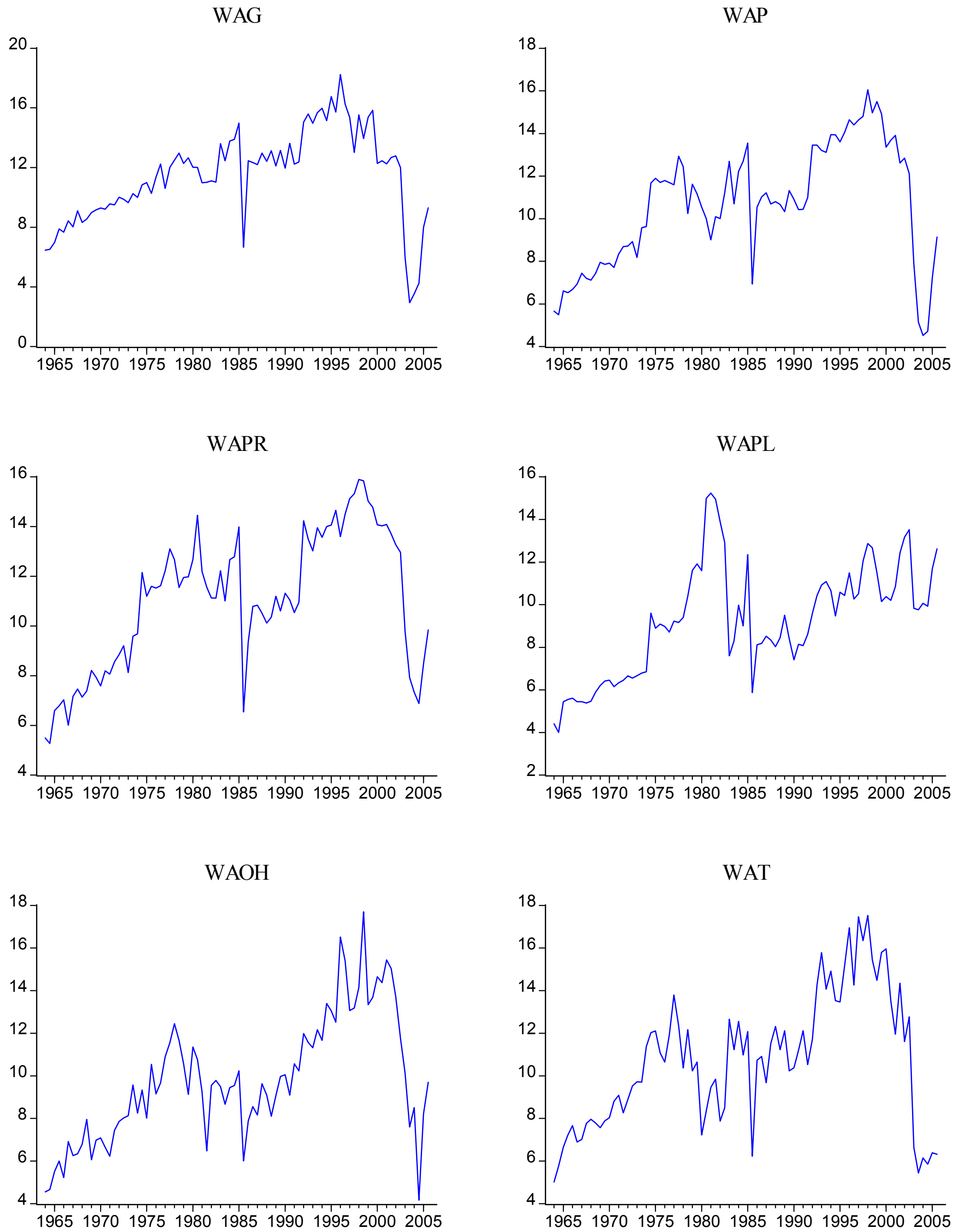




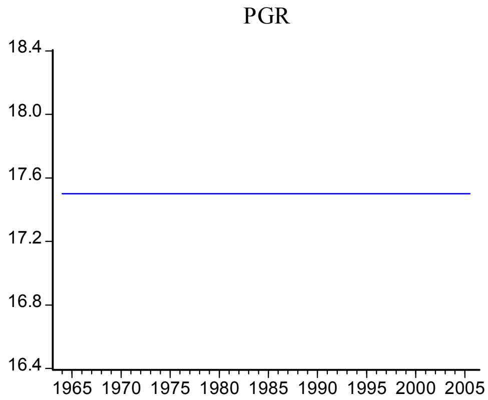
(2A.2): Exogenous variables (Rupees in Millions):

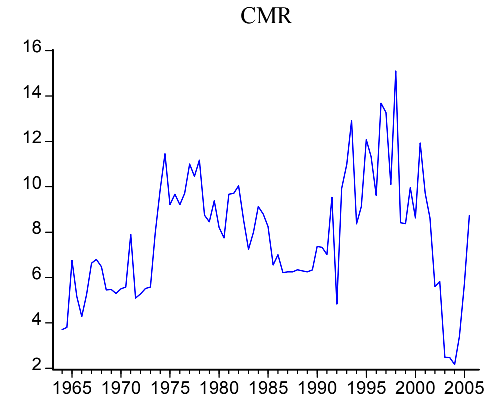


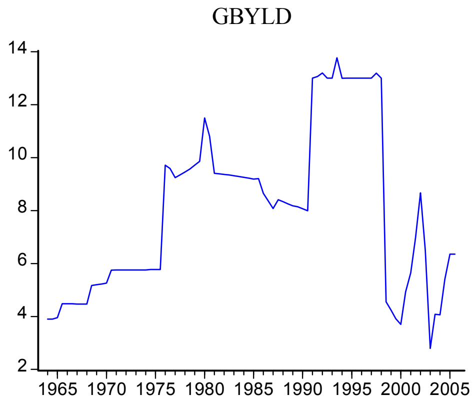
(2A.3): Interest rates (in percent):

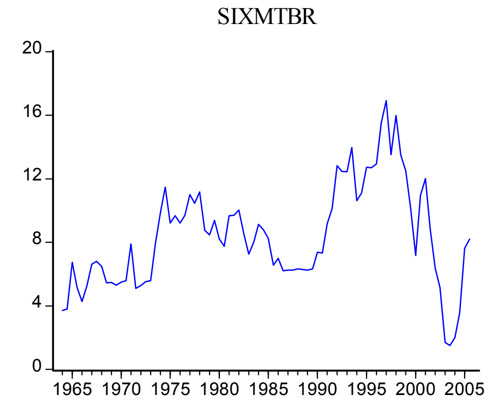


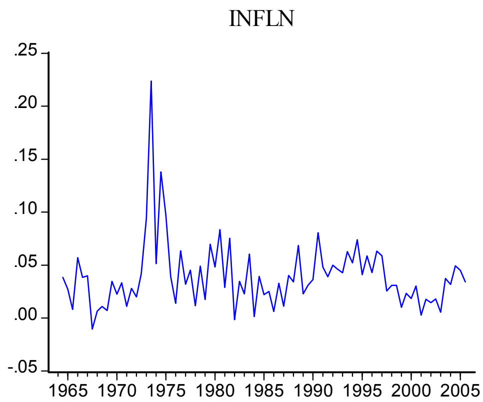
Interest rates (in percent): Continued











2.5: Descriptive Statistics of the Variables

The descriptive statistics of endogenous and exogenous variables provide in Table (2.5.2) and Table (2.5.3). Table (2.5.2) shows that the most "active" endogenous variable is Othersector, which has relative measure of dispersion of 2.00.

Table 2.5.2: Descriptive Statistics for the Endogenous Variable (million/rupees)

Variables	*Mean*	*Median*	*Maximum*	*Minimum*	*Std. Dev.*	*SD/Mean**
GOVTS	21171.14	9021.01	95077.6	52.32	25592.13	1.21
PUBS	24361.09	16034	121418	644.52	31063.55	1.28
PRIVS	209834.5	66008.85	1201391	3812.64	276837.2	1.32
PERS	29295.74	8301.45	258004.7	278.12	45990.75	1.57
OTHERS	1369.04	155.99	17571.2	4.61	2744.5	2
TRUST	2060.93	114.45	14391	3.324602	4047.982	1.96
SUMB	57775.23	23573.4	220756.2	1222.5	67744.19	1.17
FGS	55625.38	16251.15	259194.1	1267.3	69872.14	1.26
TBILLS	67324.98	10185.95	418329.3	5	108291.9	1.61
CASH	60683.99	17864.75	320122.1	868.1	81482.51	1.34

*SD/Mean measure relative dispersion

In table (2.5.3), we can see the highest relative measure of dispersion is 0.82 for Inflation with value of 0.39 and 0.38 of Gbyld and Sixmtbr are, respectively second and third highest. It is also worth mentioning that PGR is constant and has no variance.

Table 2.5.3: Descriptive Statistics on the Main Interest Rates (%)

Variables	*Mean*	*Median*	*Maximum*	*Minimum*	*Std. Dev.*	*SD/Mean**
WAG	11.53	12.11	18.24	2.94	3.05	0.26
WAP	10.71	10.91	16.05	4.52	2.77	0.26
WAPR	11.08	11.2	15.89	5.27	2.71	0.24
WAPL	9.31	9.41	15.24	4.01	2.57	0.28
WAOH	9.88	9.56	17.7	4.17	2.88	0.29
WAT	10.83	10.91	17.52	5.44	3.07	0.28
PGR	17.5	17.5	17.5	17.5	0	0
CMR	7.9	8	15.1	2.16	2.6	0.33
GBYLD	8.04	8.18	13.77	2.79	3.1	0.39
SIXMTB	8.43	8.21	16.92	1.51	3.2	0.38
INFL	0.04	0.03	0.22	-0.01	0.03	0.82

*SD/Mean measure relative dispersion

Table (2.5.4) Shows the most active exogenous variable is Capital with a 1.47 relative measure of dispersion.

Table 2.5.4: Descriptive Statistics for the Exogenous Variable (million/rupees)

Variables	*Mean*	*Median*	*Maximum*	*Minimum*	*Std. Dev.*	*SD/Mean**
PGS	1835.05	1409.4	4170.6	75.1	1261.25	0.69
CAPRES	33918.49	7273.4	183634.4	333.7	48264.45	1.42
TTD	225870.2	70426.2	1138439	2998.5	302679.4	1.34
TDD	199866.7	61528.1	1131465	3851	270663.7	1.35
CAPITAL	20584.69	4156.7	98086.4	228.6	30213.56	1.47
RESERVE	13333.79	3294.7	85548	105.1	18570.53	1.39
TDTL	425499	131954.3	2269904	6849.5	571302	1.34

*SD/Mean measure relative dispersion

Table (2.5.5) of zero-order correlations shows there are high correlations among variables; due to the multicollinearity between many interest rates variables.

Table 2.5.5: Zero-order Correlation among Main Interest Rates (%)

Variables	*WAG*	*WAP*	*WAPR*	*WAPL*	*WAOH*	*WAT*	*CMR*	*GBYLD*	*SIXMTB*	*INFLN*
WAG	1	0.91	0.84	0.44	0.73	0.85	0.69	0.7	0.77	0.09
WAP	0.91	1	0.94	0.54	0.85	0.91	0.74	0.59	0.82	0.05
WAPR	0.84	0.94	1	0.72	0.88	0.84	0.72	0.6	0.79	0.07
WAPL	0.44	0.54	0.72	1	0.61	0.41	0.45	0.44	0.46	0.01
WAOH	0.73	0.85	0.88	0.61	1	0.79	0.61	0.45	0.71	0
WAT	0.85	0.91	0.84	0.41	0.79	1	0.7	0.54	0.77	0.09
CMR	0.69	0.74	0.72	0.45	0.61	0.7	1	0.58	0.9	0.17
GBYLD	0.7	0.59	0.6	0.44	0.45	0.54	0.58	1	0.66	0.15
SIXMTB	0.77	0.82	0.79	0.46	0.71	0.77	0.9	0.66	1	0.16
INFLN	0.09	0.05	0.07	0.01	0	0.09	0.17	0.15	0.16	1

CHAPTER THREE

MONETARY TRANSMISSION MECHANISM AND LONG-RUN RELATIONSHIP BETWEEN THE BANKING SECTOR'S BALANCE SHEET AND THE MACROECONOMY IN PAKISTAN

3.1: Introduction:

In this chapter we investigate the links between monetary policy, the Banking Sector and the (aggregate) real economy in Pakistan over a forty year period, which commences in 1964. We have focused here to study how banks play a vital role in the monetary transmission mechanism through the banking credit channel. For highlighting the role of banking sector in monetary transmission mechanism, we note some arguments from the literature.

Fazzari, Hubbard and Peterson (1988) have provided evidence that internal finance is more preferred than external finance for firms. They have made assumption that external finance is more costly than internal finance, because of asymmetric information, while generate agency problems, and basically generate financial constraint. Further, a premium on external finance is an inverse function of a borrowers net worth and variables such as cash flow are very important explanatory variables for investment. Therefore, the existence of financial constraints that may cause or propagate the business cycle, investment expenditure will be affected.

On the other hand, Modigliani and Miller (1958) have demonstrated that a firm's financial structure is irrelevant to investment. They have supported their statement by the argument that a firm can raise any desired level of funds at a prevailing interest rate to finance its investment in a perfect financial market. As external finance is a perfect substitute for internal finance, therefore, the firm's investment is independent of its financial structure that is basically dependent on the investment opportunity.

By looking at both arguments, we can see in the case of limited ability of a firm or especially in the case of a small firm that can not provide internal finance for investment can go to the bank, then restriction on banks, or high interest rates, will inhibit their ability to raise finance (Ceccheetti(1999)). Generally, banks have important role in transmitting monetary policy to the real economy.

The rest of the chapter is organized as follows. Section 3.2 gives overview of the monetary transmission channels. Section 3.3 describes an econometric methodology: VARs, VECs and cointegrating relationships. Section 3.4 provides the estimates of VARs, MTMs, impulse responses, variance decompositions and identified long- run relationships. Section 3.5 discusses the innovations in the monetary policy indicator variables in the 2 models and innovations to exogenous monetary policy instruments and section 3.6 provides the summary of the chapter.

3.2: Theoretical Overview of the Monetary Transmission Channel

Monetary Transmission Mechanism (MTM) is a process through which monetary policy is executed to endeavour to effect changes in real GDP and inflation. MTM could operate through different channels, e.g. (1) the money or interest rate channel; (2) the bank lending (credit) channel, or "broad lending (credit) channel"; (3) the exchange rate channel; and (4) the expectations channel. The last two channels are included in the literature over recent years due to the floating of exchange rates, foreign exchange crises, and the influence on markets and on the information/actions of Central Banks, of “the rational expectations” revolution.

According to the money or interest rate channel, output will be affected by the changes in monetary aggregate. This argument is based on the assumption that the reduction in money supply will raise the nominal interest rate at a given rate of inflation. If the rate of inflation does not increase coincidentally with the hike in interest rates; the real rate of interest will increase. That will tend to reduce investment in plant and machinery; with subsequent negative multiplier effects on aggregate output, future profits and net worth. The money or interest rate channel can be explained as follows,

$$M\downarrow \rightarrow r\uparrow \rightarrow I\downarrow \rightarrow Y\downarrow$$

Monetary tightening (reduction in M) leads to an increase in the real rate of interest (r) that will cause to raise the cost of capital which will affect the investment (I) and that will eventually decrease aggregate output (Y). Further, a point to be noted here, in this transmission channel, there is no bank role and it is the simplest, and most direct, transmission from monetary policy to the real sector.

As asymmetric information exists in financial markets and banks are considered to be better handler of such information issues than other lenders, therefore, the role of banks is central in bank lending (credit) channel. The basic view of the transmission mechanism of the bank lending (credit) channel can be presented as follows,

$$M\downarrow \rightarrow \text{Deposits}\downarrow \rightarrow \text{Loans}\downarrow \rightarrow I\downarrow \rightarrow Y\downarrow$$

According to the above presentation, monetary contraction (*M*) leads to decrease in bank deposits and reserves that will ultimately decrease the bank loans, which will create negative affect on Investment (*I*) and output (*Y*) subsequently.

The bank lending (credit) channel can, further, be divided into two channels i.e, the balance sheet channel and bank lending channel. The purpose of the balance sheet channel is to study the impact of monetary contraction on borrower's assets and profit. This impact can be seen in the following:

$$M\downarrow \rightarrow r\uparrow \rightarrow \text{Cost of Servicing Outstanding}\uparrow\rightarrow \text{Profit}\downarrow \rightarrow \text{Asset Value}\downarrow\rightarrow$$
$$\text{Collaterals}\downarrow \rightarrow\text{Net Cash Flow}\downarrow\rightarrow I\downarrow \rightarrow Y\downarrow$$

Monetary contraction (*M*) leads to an increase in the real rate of interest (*r*), due to which banks will raise the risk premium on the cost of loans to firms that will have negative impacts on a firm's profit, asset value, collateral, net cash flow, and therefore, the firm will be able to borrow less: ceteris paribus, investment and subsequently, aggregate output, will fall. Moreover, the ability of firms to gain access to external finance is impaired by the increase in asymmetric information and moral hazard engendered by the increase in interest rates, which weakens their balance sheets.

The second interpretation of the banking/lending channel considers the sources of borrowed funds that are available to businesses. Small firms, with limited net worth, might only be able to raise external funds form banks, accordingly, when monetary policy is tightened, for the kind of reasons adduced above, they will be credit-constrained. This is also a possibility, of course, for "large" firms: but they might have access to alternative sources of finance, such as corporate bond or equity markets. In rudimentary capital markets that will not be possible and so this could increase the dependency on the banks: aggravating the reduction in capital investment.[1] We can explain these in the following:

$$M\downarrow \rightarrow r\uparrow \rightarrow \text{Deposit}\downarrow \rightarrow \text{Assets}\uparrow \rightarrow \text{Loans}\downarrow \rightarrow I\downarrow \rightarrow Y\downarrow$$

Monetary contraction decreases bank reserves and at the given reserve requirements (CRR: cash reserve requirement and LRR: liquidity reserve requirement), banks' deposits fall. On the other hand, this monetary contraction increases the interest rates including the interest rates of risk-free assets i.e Treasury Bills and Government Bonds. Due to the reserve requirements imposed by the central bank, banks are not in position to increase their deposit rates; therefore, investors take out and invest them in more lucrative assets. Firms find no difference between borrowing from the banks or issuing debt in the market, as bank lending rates should not be increased more than corporate or equity market rates. But on the other hand, all firms are not able to issue

[1] These two channels and their subdivisions (of the kind pointed out above) have been surveyed in many excellent papers. We just note, for example, Bernanke (1993), Gertler and Gilchrist (1993), Kashyap and Stein (1994), Hubbard (1995), Bernanke, Gertler and Gilchrist (1996).For a kind of "survey of the surveys" see also, Cecchetti (1995).

debt on the market. This will further aggravate to decline in bank loans, subsequently further decreasing investment and output.

In regard to the foreign exchange rate channel, the foreign exchange rate can simply be regarded as an additional intermediary between interest rate changes and output in the two main channels. Thus:

$$M\downarrow \rightarrow r\uparrow \rightarrow \mathrm{E}\downarrow \rightarrow \text{Domestic Currency}\uparrow \rightarrow Y\downarrow$$

Thus, as the interest rate increases due to a monetary contraction it reduces output both directly and indirectly (through the exchange rate) shall the market expect further depreciations, with consequences for exports, imports and so for aggregate output. Obviously, any overall impact on the latter will depend upon many inter-dependent factors, such as: the type of exchange rate regime; the impact of the exchange rate on exports, which will be dependent upon imports, and on imports; and, the relationships between output, exports and imports.

The expectation channel is also one that can be incorporated into the two main channels. Its main thesis is that expectations of inflation (which can obviously be determined by the exchange rate as well as the rate of interest) and the general state of the economy play a crucial in the monetary transmission mechanism, as monetary policy and economic development affect the formation of expected inflation which in turn influences the behaviour of economic agents. Any changes in economic behaviour translate into investment and consumption decisions which lead to changes in aggregate demand and inflation. For example, in the case of a financial crisis, possible expectations of a further decline in economic activity and inflation could reduce the time-path of the expenditure of households and businesses as they strive to strengthen their liquidity positions: thereby helping to generate the expected outcome. In this study we focus on the two main channels. The possible role of the exchange rate has to be ignored because we use data from the time post-Second World War when the most reliable data are available for Pakistan on the major variables claimed to be involved in the monetary transmission mechanism. This is 1964: and the long run of observations is used in order to assess the possibility of discovering long-run cointegrating relationship between monetary policy, the banking sector and the real economy. The consequence is that we cannot obtain reliable data (except from around 1990) on the exchange rate, and so on the real effective exchange rate. Expectations are also omitted: in any event, those that might be significant are those regarding the foreign exchange rate.

3.3: MTMs: Econometric methodology: VARs, VECs and cointegrating relationships

3.3.1: VARs

By far the dominant methodology used in the literature for investigating the monetary transmissions mechanisms is the VAR, consequent to the pioneering work of Sims (1980). The impulse responses functions and variance decompositions that it generates, makes it possible to identify which, if any, MTM appears to be operating in a given economy, and enables an assessment of its short- and long- term effects. Following on from the subsequent developments on multivariate unit roots by Johansen (for example, 1988(a), 1988(b), 1995, and 1996), it is possible also if, say, all the variables in a particular VAR are not I(0), to evaluate the possibility that the variables are cointegrated, with the consequent possibility that long-term relationships between the monetary/banking sectors and the real economy can be uncovered and then identified.[2]

A by now familiar approach to the specification of a VAR for analysis of monetary transmission channels, is the semi-structural form, adopted by Bernanke and Blinder (1992). That can be formulated as:

$$Sy_t = A(L)y_t + \varepsilon_t : E(\varepsilon_t) = 0;\ y_t = 1 \times n \tag{1}$$

$A(L)$ is a matrix polynomial in the lag operator L for a VAR(p):

$$A(L) = A_1 L + A_2 L^2 + \ldots + A_p L^p \tag{2}$$

Any structural contemporaneous parameters on the endogenous variables are, of course, contained in the matrix *S*. Following the literature on MTMs, we assume that the vector y_t contains no exogenous economic variables; though in the estimation of the VARs we incorporate *deterministic terms*, intercepts and a time trend, as will be seen later. The vector y_t contains one variable to encapsulate the "strength or weakness" of monetary policy, the "indicator variable", and a set of endogenous variables (as just implied, exogenous variables are excluded here as is generally the case in studies of MTMs) which help to determine it: and which the monetary authority is regarded as endeavouring to influence by its monetary policy instruments. The MA representation of equation (1) is:

[2] Johansen's work, of course, relied upon the Representation Theorem of Engle and Grainger (1987) which they had developed for a single-equation, OLS, approach to cointegration.

$$y_t = \Theta(L)\varepsilon_t : \Theta = [S - A(L)]^{-1} \qquad (3)$$

Where $E[\varepsilon_t] = 0$ and, as in Sims (1980)[3], $E[\varepsilon_t \varepsilon_t^{'}] = I_n$. In this case $E[\varepsilon_t \varepsilon_t^{'}]$ will be I_n if $y_t = n \times 1$, the matrices S and A_p being conformable with the y vector. L^p is the lag operator, where p describes the order of the VAR.

The reduced form of equation (1) is:

$$y_t = S^{-1}A(L)y_t + u_t : u_t = S^{-1}\varepsilon_t \qquad (4)$$

Hence:

$$E(u_t u_t^{'}) = \Omega = (S^{-1}\varepsilon_t)(S^{-1}\varepsilon_t)^{'} = (S^{-1})(\varepsilon_t \varepsilon_t')(S^{-1})' \qquad (5)$$

If we assume, as in Sims (1980), that $E(\varepsilon_t \varepsilon_t') = I_n$ then:

$$\Omega = (S^{-1})(S^{-1})' \qquad (6)$$

So S^{-1} is the Cholesky decomposition of the reduced-form covariance matrix.

From the moving average (MA) representation of the system (equation (3)), it follows that for the system to respond in a stable manner to any given random disturbance, so

---

[3] That is, the structural disturbances are orthogonal (and so independent). Therefore the Choleski decomposition of Ω provides the zero restrictions (to complement the $\frac{1}{2}p(p+1)$ constraints) on Ω needed to identify the elements of S^{-1}. The latter, of course, being this lower-triangular matrix:

$$\begin{bmatrix} S_{11} & 0 & 0 & 0 \\ S_{21} & S_{22} & 0 & 0 \\ S_{31} & S_{32} & S_{33} & 0 \\ \vdots & \vdots & \vdots & \vdots \\ S_{n1} & S_{n2} & S_{n3} & S_{nn} \end{bmatrix}$$

that over time the responses approach 0, it must be mathematically stable, in that the roots of the matrix polynomial, $\left|I_n - (S)^{-1} A(L)\right| = 0$, must lie outside the unit circle in absolute value, or are 1 in the presence of cointegration, and hence, of unit roots, in the VAR. Alternatively, if the VAR is written in companion form, that the roots of the companion matrix should be less than one in absolute value or are equal to plus 1 in the presence of cointegration.[4]

Employing the Choleski decomposition to uncover the structural innovations means that the system is then a recursive model or Wold-causal chain; the way in which the

[4] In converting the VAR into a first-order system the use of the companion form makes the mathematical stability condition transparent. If we let: $(a)\,\Pi_i = S^{-1}A(i); (b)\,\hat{y}_t = (y'_t, y'_{t-1}, \ldots, y'_{t-p+1})'; (c)\,\hat{\varepsilon}_t = (\varepsilon'_t, 0, 0, \ldots, 0)'$, the companion form of the system is:

$\hat{y}_t = Z\hat{y}_{t-1} + \hat{\varepsilon}_t$, where:

$$Z = \begin{pmatrix} \Pi_1 & \Pi_2 \cdots & \Pi_{p-1} & \Pi_p \\ I & 0 \cdots & 0 & 0 \\ \vdots & \vdots & \vdots & \vdots \\ 0 & 0 & I & 0 \end{pmatrix}$$

Here the "diagonal below the diagonal" consists of identity matrices. Covariance-stationarity holds if the eigenvalues of Z all lie inside the unit circle. Thereby any disturbance eventually dwindles to zero, since as the matrix Z is raised to the power of t, as t approaches infinity, it approaches a null matrix; and we have the same condition required to render a deterministic first-order difference equation stable. Since the eigenvalues of Z satisfy:

$\left|I_n\lambda^p - \Pi_1\lambda^{p-1} - \Pi_2\lambda^{p-2} - \cdots - \Pi_p\right| = 0$ (see, for example, Hamilton (1994)). Hence the VAR is stable for provided $|\lambda| \leq 1$ for all values that satisfy this equation. The roots of the companion matrix are then obviously the reciprocal of those of the matrix polynomial (Hamilton (1994) and Johansen (1996)).

variables affect each other is determined by their position in the ordering. In this sense, the contemporaneous innovations in the other variables influence all those below them in the chain and none of those variables above them in the order (footnote 7).

Accordingly, Sims (1992) maintained that the leading indicator of monetary policy should be ordered first if (it is assumed that) there is no contemporaneous feedback from non-policy variables onto that indicator. Thus, if it is assumed that the monetary policy decisions are set without considering the simultaneous evolution of economic variables; such as when information on non-policy variables is not readily available to the monetary or policy-making authorities. Furthermore, should it be thought that the indicator variable responds to contemporaneous feedback from non-policy variables, the policy variable should be placed last in the chain.

Having said this, it does not matter how the variables are ordered for the calculation of impulse responses and variance decompositions, if the correlations between the error terms from the estimated VAR are zero or virtually so. There exist, of course, alternative approaches to generating a set of orthogonal innovations, such as the generalised impulse responses formulated by Pesaran and Shin (1998). In their formulation, the impulse responses from an innovation to the *i*-th variable, are obtained from having computed a Choleski decomposition with the *i*-th variable ordered as the first variable. Such responses will be identical to those obtained from the Choleski decomposition on the “original” system if the correlations between the innovations in the VAR are zero.

The impulse responses derived from the moving average formulation of the system provide the information on the monetary transmission mechanism, tracking as they do the impacts of a ceteris paribus, one standard deviation innovation to the monetary indicator, on the other variables instantaneously and over time. Stability of the system guarantees that those effects eventually dwindle to zero. Those impulses over the "short run" and the cumulative, "long run", impacts are analysed for our models. Likewise the consequent variance decompositions of the variables after an innovation to themselves and the other variables are noted.

3.3.2: VECs and cointegrating relationships

In addition to using the VARs to ascertain what kind, if any, MTM, operates in a given economy, they can be utilised to evaluate the presence or otherwise of long-run relationships between the variables in the system, and ideally, between the policy indicators and the key variables in the banking/financial system. Such associations require the discovery of cointegrating relationships between particular variables; and the estimation of vector error correction models (VECMs). Expanding equation (4) we have:

$$y_t = \Pi_1 y_{t-1} + \Pi_2 y_{t-2} + \cdots + \Pi_p y_{t-p} + \varepsilon_t ; \Pi_i = S^{-1} A(i) \tag{8}$$

This can be written in VEC format:

$$\Delta y_t = \Pi y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta y_{t-i} + \varepsilon_t \tag{9}$$

Here: $\Pi = \sum_{i=1}^{p} \Pi_i - I; \, and, \Gamma_i = -\sum_{k=i+1}^{p} \Pi_k$ (10)

From Granger's representation theorem (1987) we can write the long-run matrix as:

$$\Pi = \alpha\beta' : \alpha = n \times r, \, \beta' = r \times n, \, r \le n \tag{11}$$

In equation (11), r denotes the rank of the matrix Π; which for cointegration to be present must be of reduced rank, $r < n$. The matrix β' contains the coefficients in the cointegrating relationships between the n variables; which provide the error correction, disequilibrium, terms to which the coefficients in the matrix α determine how, if at all, any disequilibrium changes the endogenous variables. The trace statistic developed by Johansen is used to determine *r*, the number of cointegrating relationships in the VARs that follow.

When cointegration is found, of course, the cointegrating vectors are not necessarily identified (unique).[5] Normalisations are employed to obtain the vectors, and that suggested by Johansen (1996) is frequently adopted.[6] The vectors can only be identified by the imposition of parameter restrictions that follow from economic theory as such, or as in the case of MTMs, which are suggested by the possible relationships between the monetary indicator variable and the portfolio activities of the banking sector and its possible linkages with the real sector. For example, it might be possible to identify a long-run relationship between bank lending, the monetary policy indicator variable (such as an interest rate) and GDP. In this econometric study we have sought to identify such relationships. The Likelihood Ratio tests for

[5] As Johansen ((1996), pp.71-72) noted:
The parameters in α and β are not uniquely identified in the sense that given any choice of α and β and any non-singular matrix $\xi(r \times r)$ the choice of $\alpha\xi$ and $\beta(\xi')^{-1}$ will give the same matrix Π and hence determine the same probability distribution for the variables. One way of expressing this is to say that what the data can determine is the space spanned by the columns of β …., and the space spanned by α ….

[6] Some software packages, such as EViews, use alternative normalisations, though it does provide the Johansen normalisation: however, it does not identify the vectors.

determining whether cointegrating vectors have been identified and the restrictions that have been imposed to identify them do hold, are detailed in Johansen ((1995), (1996)).

3.4: Estimation of VARs: MTM, impulse response, variance decompositions and identified long run relationships

3.4.1: Variables, monetary policy indicators and the data

As discussed in introduction of this chapter, the variables in our VARs are for the aggregate banking sector. To get insight into the credit channel via the notion of "credit constrained" sectors or industries, we have processed the data on bank loans into those to two broad categories of borrowers: government and government-related sectors and non-government, or private/personal, sectors. This division has to bear a heavy burden, as it were, because it is endeavouring to capture the idea that small enterprises/groups might be unable to obtain credit in a period of monetary contraction, because for various reasons, there only source of finance is the banking sector. The loans to the two sectors are simply labelled: *TLps*, for total loans to the public sector; and *TLnps*, for total loans granted to the non public sector, or private sector, the "*n*" , that is, stands for *non*. The raw data are transformed into logarithms for the purposes of estimation. The deposits of the banking sector are summed across both times of deposits: again the logarithms of these are used in the estimation. They are assigned the notation, *TDeps*. The other major component of the banking sector's portfolio which alters with changes in the conditions that affect loans and deposits, are government ("federal") securities: these we label *Fgs*, and they also are used in their logarithmic form. The real sector variables included are the price level (*Cpi*) and the log of real GDP (*GDP*). The remaining variable in the VARs is an indicator of the strength or weakness in the monetary/banking sector.

The State Bank of Pakistan's basic monetary control mechanisms have not altered radically over the years, and in the past as now (see, for example, Agha et.al., 2003), it seems to use the Treasury Bill rate as its policy indicator. This is similar to the situation in the USA where the Fed Funds rate is used as the indicator. Therefore, a short term interest rate, determined by the buoyancy in the sector, such as the six month Treasury Bill have been used as an appropriate choice in the test VARs.

In the following we report on two models. Model (1) contains these variables: *Sixmtbr, TLoans, Fgs, TDeps, Cpi* and *GDP*. Model (2) differs from Model (1) in that *TLoans* are separated out into *TLps* and *TLnps*.

The data are graphed in Appendix A. The graphs reveal that many variables have trends; and so a trend is included in the VARs. Additionally, a trend was included in the unit root tests when appropriate, and was indicated to be so by the test statistics under both the ADF and Phillips-Perron tests. The ADF tests found all variables to be I(1), and this was the case except for *TLps* which was I(1) by the Phillips-Perron tests; and the latter found *M* to be I(1), whilst the ADF test indicated that at just under the 10% level it was I(0). The latter, however, can be taken to be too high a significance level.[7]

[7] The ADF statistics, on the levels of the variables, are: *Sixmtbr*, -2.546 [0.11]; MB, -2.393 [0.381]; *Discrate*, -1.822 [0.367]; *TLoans*, -2.351 [0.402]; *TLps*, -2.751 [0.220]; *TLnps*, -2.874 [0.176]; *TDeps*, -2.531 [0.313]; *Fgs*, -1.813 [0.690]; *Cpi*, 2.428 [1.00], and for *GDP*, -1.330 [0.612].

3.4.2: Estimates of VARs and Identified Cointegrating Vectors

3.4.2.1: Model (1)

The estimates of the best VAR are given in Table 3.1, with lag length 1.

Table 3.1 Model (1): VAR estimates

	Sixmtbr	*TLoans*	*Fgs*	*TDeps*	*Cpi*	*GDP*
Sixmtbr(-1)	0.777	-0.005	0.000	0.002	-0.050	-0.255
	-0.063	-0.002	-0.006	-0.002	-0.038	-0.070
	[12.381]	[-2.474]	[0.069]	[0.727]	[-1.316]	[-3.624]
TLoans(-1)	-1.136	0.716	-0.344	-0.120	-3.438	8.058
	-2.524	-0.075	-0.229	-0.084	-1.522	-2.828
	[-0.450]	[9.481]	[-1.500]	[-1.427]	[-2.258]	[2.849]
FGS(-1)	-0.008	0.034	0.903	0.035	0.528	1.185
	-0.742	-0.022	-0.067	-0.025	-0.448	-0.832
	[-0.011]	[1.520]	[13.405]	[1.407]	[1.179]	[1.425]
TDeps(-1)	5.365	0.236	0.284	0.781	4.830	0.770
	-2.306	-0.069	-0.209	-0.077	-1.391	-2.584
	[2.326]	[3.429]	[1.358]	[10.121]	[3.473]	[0.298]
Cpi(-1)	0.041	0.000	-0.001	-0.002	1.041	-0.077
	-0.028	-0.001	-0.003	-0.001	-0.017	-0.032
	[1.435]	[0.091]	[-0.440]	[-2.571]	[61.128]	[-2.431]
GDP(-1)	0.075	0.001	0.003	-0.001	0.058	0.853
	-0.041	-0.001	-0.004	-0.001	-0.025	-0.046
	[1.814]	[0.959]	[0.751]	[-0.884]	[2.336]	[18.432]
Intercept	-36.255	0.187	1.042	2.738	-17.152	-73.123
	-21.101	-0.631	-1.916	-0.706	-12.727	-23.645
	[-1.718]	[0.296]	[0.544]	[3.879]	[-1.348]	[-3.093]
T	-0.751	-0.005	-0.002	0.032	-0.459	0.161
	-0.274	-0.008	-0.025	-0.009	-0.165	-0.307
	[-2.747]	[-0.658]	[-0.092]	[3.451]	[-2.782]	[0.526]
R^2	0.797	0.999	0.994	0.999	0.999	1.000
$\overline{R}^2$	0.778	0.999	0.994	0.999	0.999	1.000
S.E. equation	1.517	0.045	0.138	0.051	0.915	1.700
Log likelihood	-146.319	141.463	50.412	132.281	-104.862	-155.653

Further properties of these equations and of the system are given in Appendix B. Those attributes cover the eigenvalues of the companion matrix, the test for lag length and the properties of the residuals.

Figure 3.1: Impulses to 1 standard deviation innovation to Sixmtbr: Model (1)

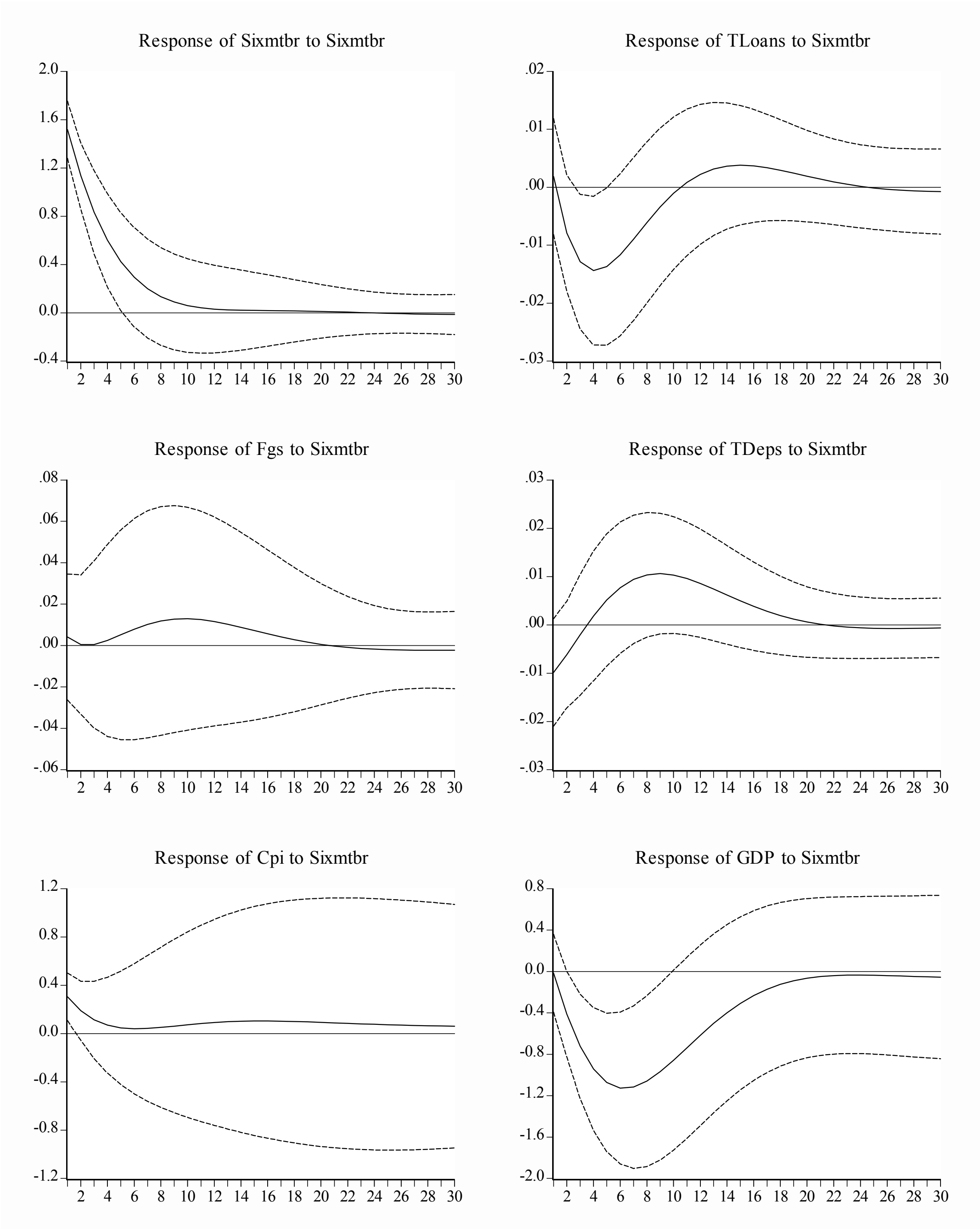
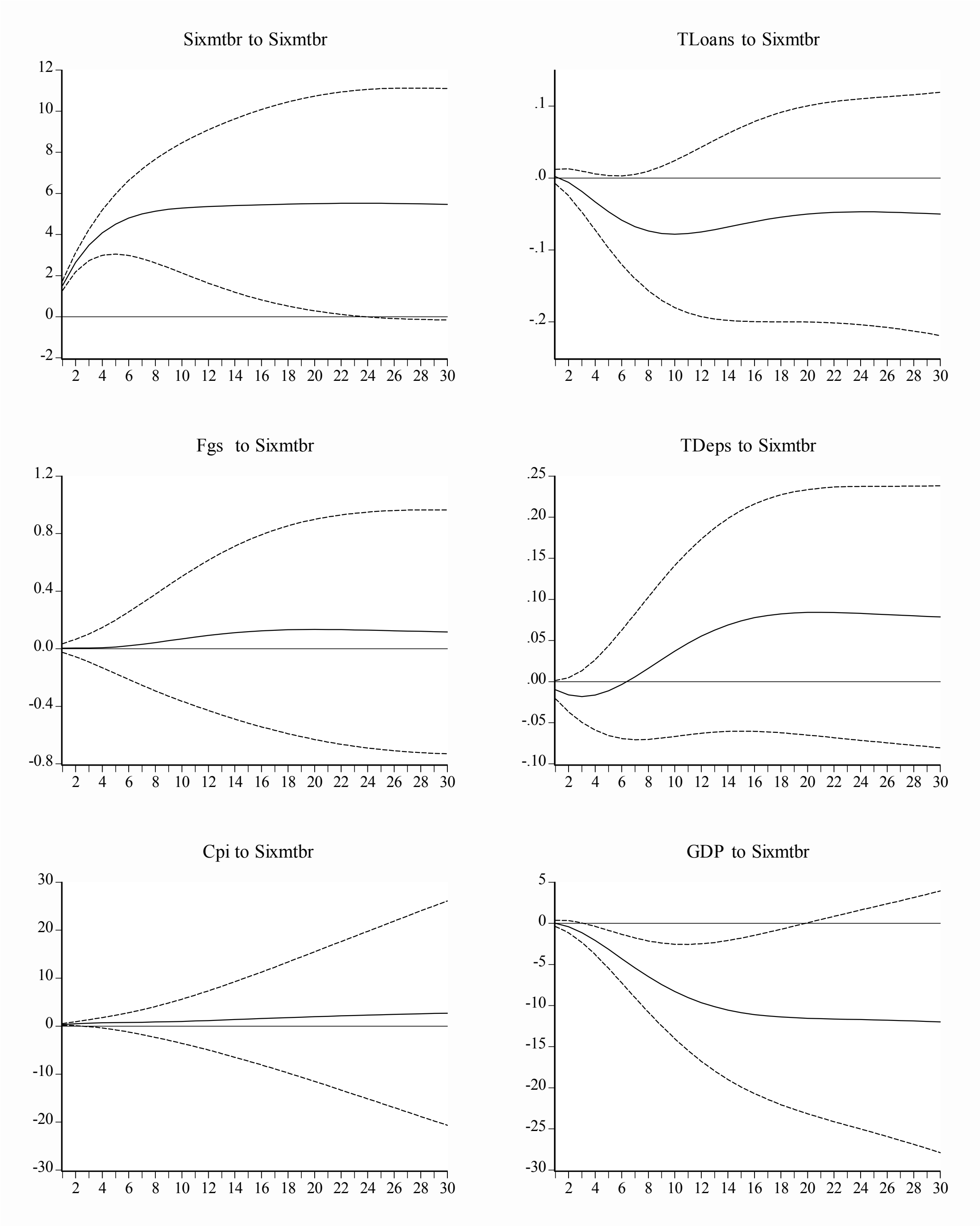


Figure 3.2: Cumulated response over 30 periods: Model (1)



The period-by-period impulse responses in Figure (3.1) show that the rise in the short term interest is maintained for something like six years; though only the initial period changes are "reasonably" statistically different from zero.[8] After a tiny increase in total loans, they fall consistently for five years. Total deposits fall immediately, doing so for two years, but raise continually over that period from their initial fall. These impacts can be linked through interest rates and GDP, possibly also via the real rate of interest; thereby providing some support for the money view of the MTM. For example, the increase in the money rate of interest, which for given inflation rate clearly raises the minimum return on capital investment that must be used to evaluate expenditure on plant and machinery. In fact, the real rate increases for a period of four years, though its increases decline exponentially from the first period. It could then be suggested that those increases had a negative impact on the propensity to invest in capital equipment. The consequence, other things being equal, would be a decline in GDP; which latter we see from Figure 3.1.

In an economy, such as that of Pakistan, which in the majority of the years of our sample did not possess an advanced Stock Market, the concomitant of which we would conjecture would be a fall in the demand for loans from the Banking Sector. Such a fall would also be partly occasioned by that sector being more cautious of the increased moral hazard then attaching to any investment plans of potential borrowers. Deposits begin to recover quickly, whilst loans to not cease falling until five years later. That is when, others things being given, recovery in GDP begins. We notice that

[8] In almost every set of impulse responses in the literature the standard errors of impulse responses tend to be large. Those for the immediate periods tend to be lower than others; and some, as here, do indicate that the impulses are significantly different from zero.

much of the discrepancy between deposits and loans is taken up by increased holdings by the Banking Sector of government securities, Fgs. The cumulative impulse responses over the 30 periods are graphed in Figure (3.2). For the initial periods the standard error range is "smallish" for some of the responses; and the graphs confirm in pictorial form some of the preceding observations.

Those observations illustrate the difficulties of extricating any definite MTM, within an aggregate framework, where banks are not differentiated by bank type, loans are not differentiated by sectors (industrial, agricultural, services,…) and by type (private, government,…), and where feasible alternative means of finance for business concerns are not included (government agencies such as development funds, stock markets,…). Thus the availability of stock market data over our period would have helped to confirm or otherwise the bank lending channel which Model (1) partly points to you; and thereby to see if the interest rate was also present, or was "the" monetary transmission mechanism. Incorporation in the VAR of the distribution of loans by sector would have further aided understanding of those two main channels. That is a dimension that we can investigate in part, as we do in our variant Model (2) later.

We turn now to the variance decompositions produced by the VAR of Model (1). These are detailed in Table (3.2).

Table 3.2 Model (1): Table of Variance Decompositions: One standard deviation Innovation to the variable in the top row, impact on the variable in the left hand column

	Sixmtbr	*TLoans*	*Fgs*	*TDeps*	*Cpi*	*GDP*
After 1 period						
Sixmtbr	100.00	0.0000	0.000	0.000	0.000	0.000
TLoans	0.017	99.835	0.000	0.000	0.000	0.000
Fgs	0.090	0.584	93.326	0.000	0.000	0.000
TDeps	3.773	1.182	1.626	93.418	0.000	0.000
Cpi	11.096	0.928	0.840	0.435	86.703	0.000
GDP	0.0136	4.772	0.323	0.237	4.146	90.512
After 2 periods						
Sixmtbr	97.653	0.002	0.014	1.832	0.099	0.399
Tloans	1.919	93.057	1.061	3.849	0.007	0.107
Fgs	0.049	1.749	97.619	0.525	0.000	0.058
Tdeps	3.226	0.840	3.463	92.230	0.148	0.093
Cpi	7.177	0.459	0.399	5.056	86.415	0.494
GDP	3.115	10.656	0.325	0.151	3.155	82.599
After 5 periods						
Sixmtbr	84.151	0.011	0.983	11.807	0.451	2.597
Tloans	9.921	64.369	10.072	15.281	0.162	0.168
Fgs	0.069	5.825	92.157	1.654	0.047	0.248
Tdeps	2.621	5.125	7.689	82.181	1.578	0.807
Cpi	2.564	2.680	2.533	15.848	74.132	2.244
GDP	20.201	19.143	4.601	0.119	1.477	54.188
After 10 periods						
Sixmtbr	69.797	0.334	6.212	18.905	0.460	4.292
Tloans	10.732	49.827	20.932	15.649	2.445	0.415
Fgs	0.684	9.400	87.477	1.527	0.510	0.402
Tdeps	8.130	9.754	7.593	68.574	4.448	1.501
Cpi	1.088	7.984	8.753	18.721	59.814	3.639
GDP	32.882	16.941	12.752	0.300	4.680	32.445

These decompositions need little comment. However, we remark on the important first column. It suggests that there is a more or less immediate substantial impact on Cpi (that is, inflation increases), which declines over time, and in the "long-run" the impact is relatively small. By contrast the impact on output (GDP is in real terms we recall) is initially small and then increases until it is relatively large over two and a half years. In effect, the tighter monetary policy stance (such a reduction in the monetary base), which has produced an increase in the short term interest rate, makes a substantial contribution to the variation in output, but a correspondingly small impact on the variation in inflation. The impulse responses functions for Cpi and GDP indicate that other things equal (which, naturally, is a very strong presumption in this kind of exercise) the monetarists' suggestions are not in evidence. An increase in the interest rate will affect output both in the short and the long run: output will not fall in the short run but return to its original level in the long-run. Also, inflation will not be zero in the short run and increase in the long run (theoretically, to match the proportionate change in, say, the money supply which engendered the innovation to the short term interest rate in the VAR). Such considerations lead us on naturally to attempts to *identify long-run cointegrating relationships* between the variables in the VAR.

To do so we need to think of some possible economic or monetary policy relationships the presence of which we might explore. Obvious ones in the current context are the long-run influences on the banking sector's two main financial claims, loans and deposits. Those on the latter could be regarded as identifying a major component of the long-run demand for money. In Table 3.3 we report identified cointegrating vectors, which are graphed in Figure 3.3.[9] It will be noticed that the vectors contain a trend; so that Model 4 of Johansen (1996) was estimated. His Likelihood Ratio test (for rank 2 of the long-run matrix) for the presence of a trend

[9] We note that the findings of tests for *Unit roots*: ADF t-stats. and prob.[.]: C vector 1, , no intercept and no trend, -3.00 [0.003]; C vector 2, with an intercept and trend, -3.927[0.015].

versus (the restricted model of) no trend was, $\chi^2(2) = 10.555$, which exceeds the 5% critical value.[10]

The first cointegrating vector is normalised on total deposits, and perhaps could be regarded as a long-run demand for (or supply of, in terms of the banking sector's portfolio) deposits. Converting it into an equation indicates that in the long-run that the relationships between the short-term interest rate, output, the price level and deposits are all positive. The price level effect can be seen as a desire of the non-banking sector (if we envisage the long-run relationship as representing the non-banking sector's desired holding of deposits) to maintain what is the substantial proportion of its real balances. The trend effect is also positive. However, we observe that in this vector only the six month Treasury bill rate and the trend are statistically significant links with total deposits. When the trend is not included this remains the case. Effectively, we have a long-run relationship between the six month Treasury bill rate and banking sector deposits.

[10] The *LR* ratio is: $-N\sum_{i=1}^{r}[\ln(1-\lambda_{m,i}) - \ln(1-\lambda_{m-1,i})]$. Here: N=number of observations; *r* is the rank of the matrix under the assumption that there is a trend; m is Model 4, so that m-1 stands for Model 3; and the λs are the eigenvalues for each cointegrating rank up to *r*.

Table 3.3: Identified Cointegrating Equations in Model (1)[11]

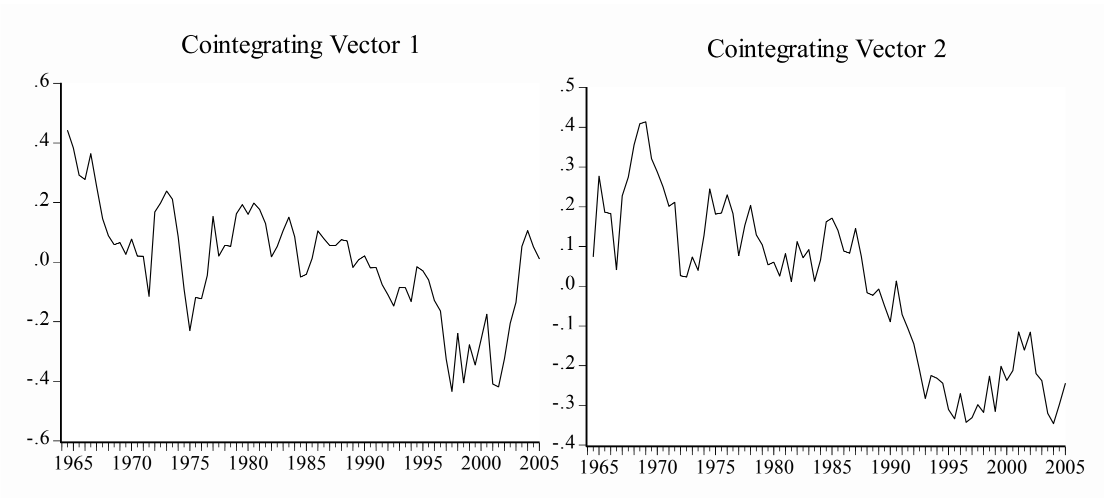
Cointegration Restrictions:		
β (1,4)=1, β (2,2)=1, β (1,3)=0, β (2,1)=0, β (1,2)=0		
Convergence achieved after 235 iterations.		
Restrictions identify all cointegrating vectors		
LR test for binding restrictions (rank = 2):		
χ^2 (1)	0.553115	
Probability	0.457048	
Cointegrating Eq:	*CointEq1*	*CointEq2*
Sixmtbr(-1)	-0.037785	0.000000
	(0.00718)	
	[-5.26061]	
TLoans(-1)	0.000000	1.000000
Fgs(-1)	0.000000	-0.043591
		(0.06424)
		[-0.67854]
TDeps(-1)	1.000000	-1.001603
		(0.19179)
		[-5.22252]
Cpi(-1)	-0.001614	-0.009190
	(0.00277)	(0.00245)
	[-0.58307]	[-3.75414]
GDP(-1)	-0.002390	-0.014129
	(0.00373)	(0.00291)
	[-0.64132]	[-4.84764]
Trend	-0.059817	0.083910
	(0.02293)	(0.02377)
	[-2.60907]	[3.53013]
Intercept	-8.282444	1.041939

*( )=standard errors; [ ] = t-stats

[11] As stated above, all degrees of freedom for the χ^2 values are based those provided in Johansen (1996). For the current system where the restrictions on the beta vectors are different and where rank *r* is required to identify each of the vectors, the number of degrees of freedom equals the sum of the differences between the number of restrictions in each equation and *r*. For *r* = 2 above, this yields 1. Effectively, the number of degrees of freedom equals the sum of the restrictions less *r*-squared

The second long-run relationship is between total bank loans, total deposits, the price level, aggregate output and the relatively riskless banking sector asset, government securites. All associations are positive. This is what would be anticipated in regard to deposits and output: since a large proportion of deposits are “loans created”, and loans as well as deposits made by all economic agents would be expected to increase in an expanding economy and one where the price level was increasing. All coefficients in this equation are statistically significantly different from zero, except for that of federal government securities.

Figure 3.3: Cointegrating relationships in Model (1)



Now we analyse model (2) differs from model (1) in that total loans (TLoans) are separated out into total loans to public sector (TLps) and total loans to non- public or private sector loans (TLnps)

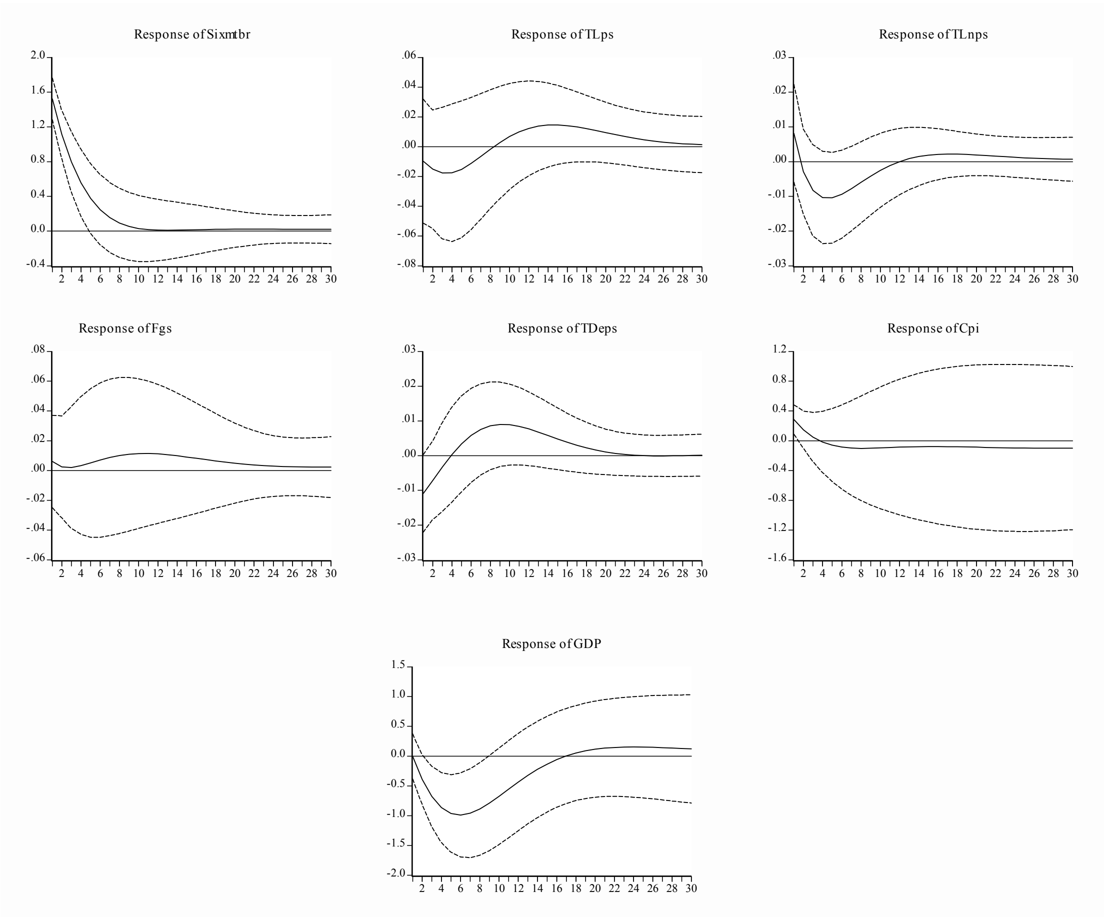
Table 3.4: Model (2): VAR estimates

	Sixmtbr	*TLps*	*TLnps*	*FGS*	*Tdeps*	*Cpi*	*GDP*
Sixmtbr(-1)	0.763	-0.003	-0.004	0.002	0.001	-0.064	-0.253
	-0.065	-0.008	-0.003	-0.006	-0.002	-0.038	-0.072
	[11.819	[-0.352]	[-1.306]	[0.270]	[0.493]	[-1.671]	[-3.514]
TLps(-1)	-0.570	0.776	0.018	-0.023	-0.036	-1.004	1.778
	-0.592	-0.073	-0.025	-0.054	-0.020	-0.352	-0.661
	[-0.963]	[10.652]	[0.725]	[-0.423]	[-1.809]	[-2.850]	[2.689]
TLnps(-1)	-0.503	0.198	0.570	-0.302	-0.039	-1.495	5.632
	-2.554	-0.314	-0.107	-0.234	-0.086	-1.520	-2.852
	[-0.197]	[0.631]	[5.336]	[-1.291]	[-0.460]	[-0.984]	[1.975]
FGS(-1)	0.112	0.011	0.022	0.889	0.039	0.643	1.152
	-0.754	-0.093	-0.032	-0.069	-0.025	-0.448	-0.842
	[0.150]	[0.116]	[0.7023]	[12.886]	[1.540]	[1.434]	[1.368]
TDeps(-1)	5.611	0.389	0.224	0.265	0.762	4.595	1.326
	-2.431	-0.299	-0.102	-0.223	-0.081	-1.447	-2.715
	[2.308]	[1.302]	[2.204]	[1.191]	[9.359]	[3.176]	[0.488]
Cpi(-1)	0.041	-0.003	0.001	-0.001	-0.003	1.037	-0.072
	-0.030	-0.004	-0.001	-0.003	-0.001	-0.018	-0.033
	[1.380]	[-0.740]	[0.933]	[-0.380]	[-2.669]	[58.399]	[-2.168]
GDP(-1)	0.075	-0.002	0.003	0.003	-0.002	0.051	0.855
	-0.043	-0.005	-0.002	-0.004	-0.001	-0.026	-0.048
	[1.752]	[-0.406]	[1.539]	[0.683]	[-1.102]	[1.998]	[17.860]
Intercept	-40.687	-3.558	1.380	1.036	2.429	-25.648	-67.977
	-21.227	-2.611	-0.888	-1.944	-0.711	-12.631	-23.704
	[-1.917]	[-1.363]	[1.555]	[0.533]	[3.416]	[-2.031]	[-2.868]
T	-0.785	-0.011	-0.004	-0.001	0.032	-0.474	0.149
	-0.278	-0.034	-0.012	-0.025	-0.009	-0.165	-0.310
	[-2.823]	[-0.331]	[-0.376]	[-0.023]	[3.401]	[-2.865]	[0.481]
R^2	0.796	0.989	0.999	0.994	0.999	0.999	1.000
$\overline{R}^2$	0.773	0.988	0.999	0.994	0.999	0.999	1.000
S.E. equation	1.523	0.187	0.064	0.139	0.051	0.906	1.701
Log likelihood	-144.237	25.516	112.896	49.390	130.873	-102.189	-153.178

Further diagnostics statistics for these estimates can be found in Appendix B.

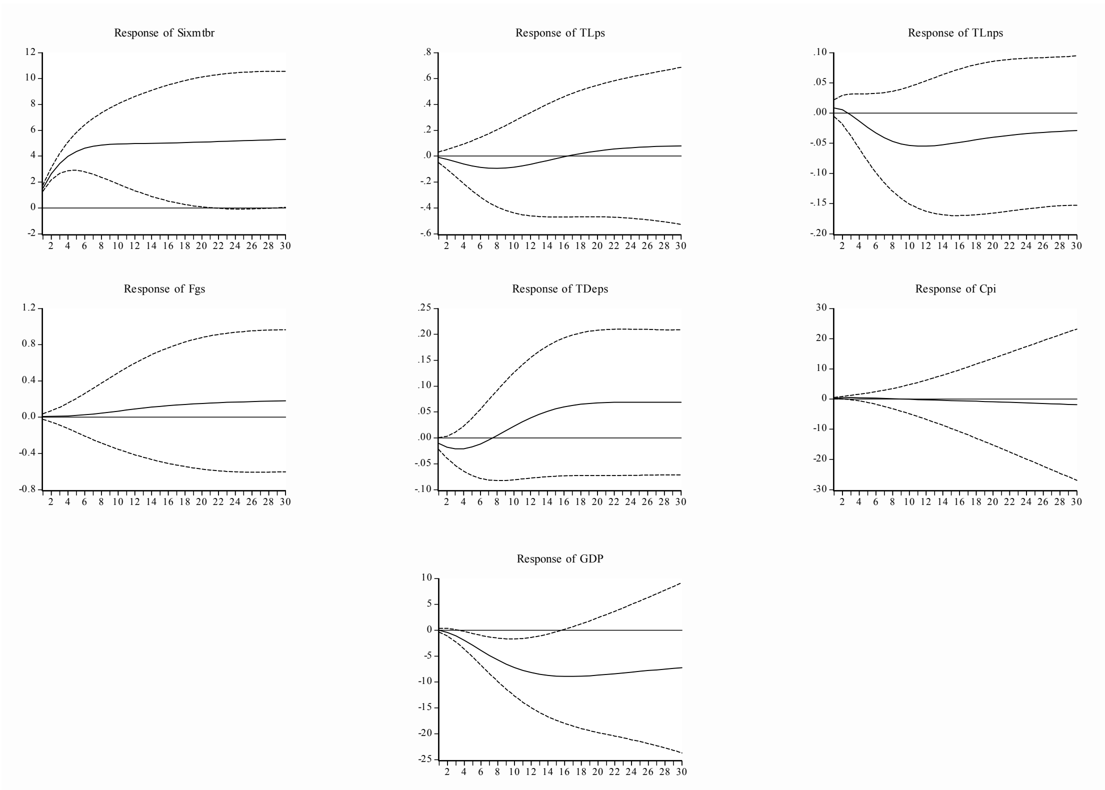
The resultant, key, impulse responses are graphed in Figure (3.4).

Figure 3.4: Impulse responses to 1 standard deviation innovation to Sixmtbr: Model (2)



As might be anticipated, the cyclical patterns of the responses are similar, indeed virtually identical, over the first 10-12 periods following the innovation to the short term interest rate. The conclusions that follow for the monetary transmission mechanism accordingly match those for Model (1). However, we see that some further information on the speed and size of the impact of the interest rate changes with respect to the price level and output is gained from the disaggregation of total bank loans. Whilst the change in total loans in Model (1) occurs after 10 periods, Model (2) indicates that the loans granted to the public sector increase after 8 periods, whilst those granted to the private sector do not so until period 12: so suggesting that the upturn in loans is due to the lending to the public sector. We further note that the change in total loans remains positive after 30 periods (15 years): which is not the case for Model (1). As a consequence we observe that output changes become positive after 16 periods, whilst in Model (1) changes in output remain negative until at least 30 periods, beginning a period of near stagnation after period 20. The early return to "normality" of loans to the public sector, has created a subsequent multiplier effect on output: and it is possible that the moral hazard to the banking sector of loans to the public sector encouraged the recovery in those loans, against the riskier private sector loans. The initial time path of the response of Cpi matches that of Model (1), but thereafter the price level continues to fall by a low, constant, amount; even when output ceases to fall. The cumulated impulse responses are graphed in Figure (3.5).

Figure 3.5: Cumulated response over 30 periods: Model (2)



The responses are similar to those in Figure (3.3), for Model (1) is, as expected given our previous discussion. The differences primarily affect the loans' responses.

Table 3.5: Variance Decompositions: Model (2)

	Sixmtbr	*TLps*	*TLnps*	*Fgs*	*TDeps*	*Cpi*	*GDP*
After 1 period							
Sixmtbr	100.000	0.000	0.000	0.000	0.000	0.000	0.000
TLps	0.271	99.729	0.000	0.000	0.000	0.000	0.000
TLnps	1.627	25.335	73.038	0.000	0.000	0.000	0.000
Fgs	0.191	0.410	1.777	97.621	0.000	0.000	0.000
Tdeps	4.544	1.196	2.811	2.505	88.944	0.000	0.000
Cpi	9.807	1.776	2.908	0.356	0.002	85.151	0.000
GDP	0.001	0.530	4.021	0.273	0.136	4.960	90.078
After 2 periods							
Sixmtbr	97.046	0.383	0.070	0.073	1.920	0.108	0.401
TLps	0.594	98.370	0.299	0.045	0.652	0.017	0.022
TLnps	1.325	22.951	72.922	0.369	2.007	0.073	0.353
Fgs	0.120	0.257	3.447	95.685	0.439	0.000	0.052
Tdeps	3.971	3.040	1.887	4.793	85.969	0.188	0.153
Cpi	5.726	5.524	2.190	0.400	2.749	83.032	0.378
GDP	2.804	1.426	8.282	0.320	0.074	3.926	83.168
After 5 periods							
Sixmtbr	79.701	3.688	0.290	2.194	11.237	0.461	2.428
TLps	1.513	91.514	0.839	0.815	4.638	0.371	0.310
TLnps	4.717	18.131	62.203	4.702	8.964	0.122	1.161
Fgs	0.117	0.222	7.037	90.918	1.493	0.058	0.155
Tdeps	2.865	8.041	2.581	10.192	73.456	1.763	1.103
Cpi	1.731	16.873	0.761	5.172	9.228	64.763	1.473
GDP	17.610	7.292	12.353	3.587	0.397	1.877	56.885
After 10 periods							
Sixmtbr	62.860	6.874	0.350	9.905	15.800	0.444	3.767
TLps	1.615	84.650	0.979	2.144	7.027	2.277	1.309
TLnps	6.438	15.720	54.134	11.529	10.247	0.824	1.108
Fgs	0.561	0.355	9.709	87.043	1.541	0.611	0.178
Tdeps	6.308	10.039	5.770	10.617	60.857	4.548	1.862
Cpi	0.868	25.187	1.042	14.666	8.977	47.192	2.068
GDP	25.858	18.238	8.946	7.507	0.425	4.766	34.260

The picture provided by Table (3.5) is naturally very similar to that provided by Table (3.2) for Model (1). The differences, of course, reflect the differences noted concerning the impact of innovations to the short term interest rate on: GDP, total loans and on itself. The variance decompositions of all three variables with respect to that rate have has declined.

For model 2 we again find that a trend should be included in the cointegrating vectors, since the LR test gives: $\chi^2(2) = 10.427$, which exceeds the 5% significance level. The cointegrating vectors are given in Table 3.6. All the restrictions are satisfied and they also are sufficient to identify the vectors.

Table 3.6: Identified Cointegrating Equations in Model (2)[12]

Cointegration Restrictions:
β(1,2)=0, β(1,3)=1, β(1,4)=0, β(2,1)=0, β(2,2)=1, β(2,3)=0, β(2,6)=0, α(1,2)=0, α(3,2)=0, α(4,1)=0, α(4,2)=0, α(5,2)=0

Convergence achieved after 63 iterations.
Restrictions identify all cointegrating vectors
LR test for binding restrictions (rank = 2):

χ^2(8)	9.422123	
Probability	0.307946	
Cointegrating Eq:*	*CointEq1*	*CointEq2*
Sixmtbr(-1)	0.032681	0.000000
	(0.00837)	
	[3.90401]	
TLps (-1)	0.000000	1.000000
Tlnps (-1)	1.000000	0.000000
Fgs(-1)	0.000000	-0.580641
		(0.21578)
		[-2.69093]
TDeps (-1)	-1.848855	-0.679540
	(0.24851)	(0.65704)
	[-7.43967]	[-1.03425]
Cpi(-1)	-0.006723	0.000000
	(0.00327)	
	[-2.05893]	
GDP(-1)	-0.008944	-0.011476
	(0.00423)	(0.00663)
	[-2.11343]	[-1,73220]
Trend	0.117510	0.048786
	(0.03385)	(0.04789)
	[3.47187]	[1.01869]
Intercept	7.731894	4.693950

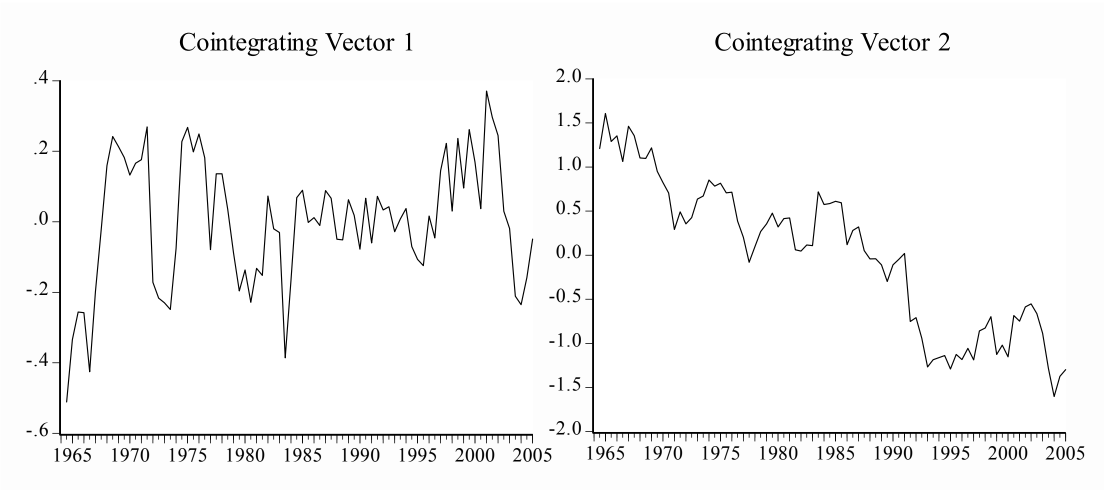
*( )=standard errors; [ ] = t-stats

[12] To the degrees of freedom for the χ^2 values given in Footnote 11, we add to these the number of the restrictions on the alphas.

Here, we have normalised on the two types of bank loans, rather on one type or the other and deposits, with the same kind of objectives in mind as with the previous models. Consider the first relationship: “private sector” loans are positively related to total deposits and to GDP, and negatively associated with the rate of interest and the price level. That would seem to be a rational outcome: whether it represents the banking sector’s behaviour or that of the non-banking sector or a combination of both. From the second relationship, public sector loans, we note: the positive link with total deposits, GDP and also with government securities. So, those loans increase as the size of the banking sector’s funds increase, as economic activity increases (when higher loans are demanded) and as one of the major “less risky” assets in the banking sector’s portfolio increases. For that asset will allow more riskier ventures to be funded. Again, here are long-run associations between monetary conditions, banking sector balance sheets and the macroeconomy. The cointegrating vectors are graphed in Figure 3.6.[13]

[13] Unit Root tests: CV1, ADF (neither intercept nor Trend), -4.525 [0.000], CV2, ADF (intercept and Trend), -3.163 [0.093], KPS (intercept and Trend), LM-stat, 0.0725 < 10% level [when < 5% level is usually taken as the level at which I(0) can be taken to be the correct order of integration.

Figure 3.6: Cointegrating relationships in Model (2)



3.5: Innovations in the monetary policy indicator variables in the 2 models and innovations to exogenous monetary policy instruments.

In the above it was assumed that the innovations in the monetary policy indicators are the consequence of actions taken by the central bank (SBP) to ease or strengthen monetary conditions in the financial markets, in the light of its objectives for the macroeconomy. It has been argued strongly by, for example, Rudebusch (1997), that unless this is the case, the VARs provide no information about the monetary transmission mechanisms. The implication is that changes to monetary policy instruments such be able to account for some if not all of the innovations to the monetary indicators (Sims (1998) was not that sympathetic to that viewpoint: nor, it might be added, to other criticisms of the VAR methodology which he had invented almost 20 years earlier). However, it seems that the point made by Rudebusch has substance and is crucial to the claims that any given monetary transmission mechanism is present in an economy. Others have agreed and, for example, Ford et al

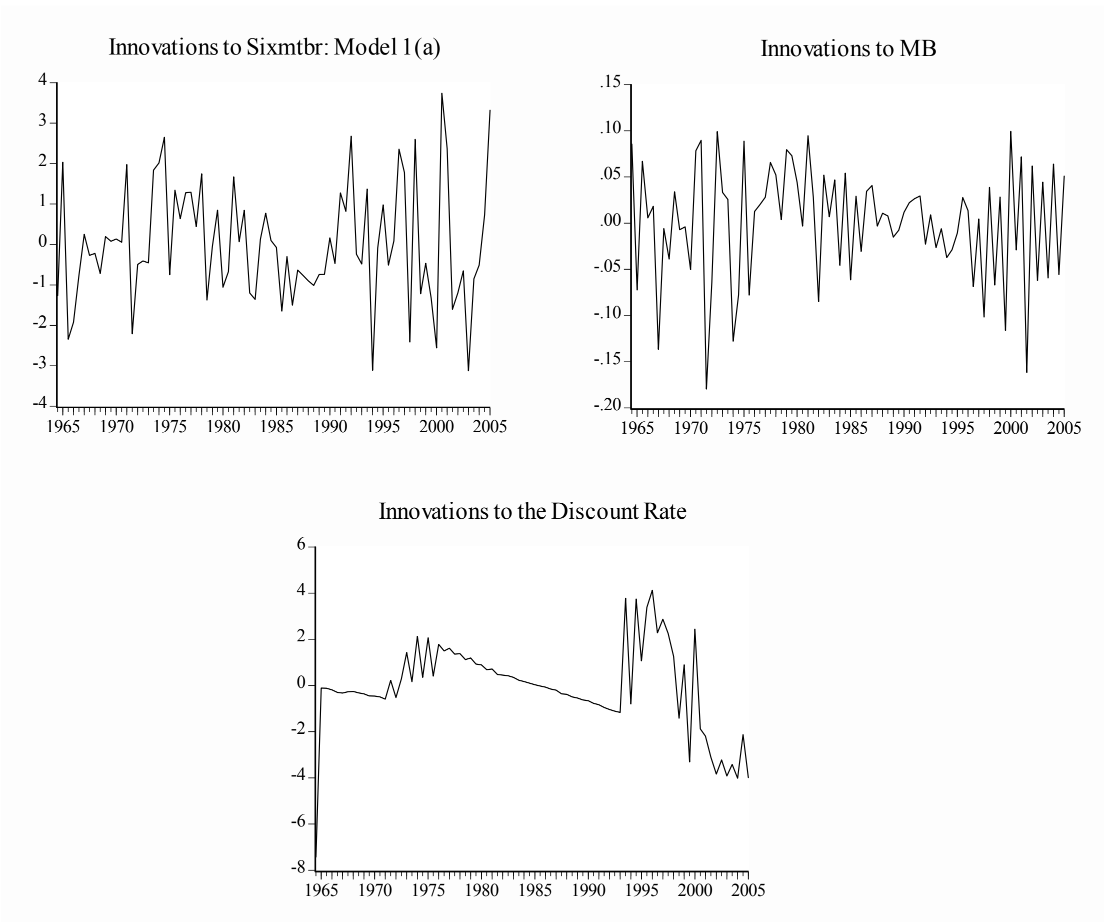
(2003) adopted this in their study of MTMs for Japan. We have done so in the following.

In order to do so it is plainly necessary to consider the monetary instruments employed by the central bank for controlling the volume and cost of finance in the banking system. For Pakistan it seems from SBP information that over the years, despite changes to the structure and constitution of the banking sector, open market operations and changes in its discount rate have been used to alter the quantity and cost of funds.

Generally we could surmise the central bank has some expectation of the level of its basic interest rate, the discount rate, that it must set in order to keep interest rates at a level that will generate its target level of GDP and maybe of the price level/inflation. Any observed divergence between that expected level and the actual level that it sets in current market conditions at any point, will trigger an increase or decrease in the discount rate. However, we have no information from the SBP what that expectation might have been at each point in time. One possible way of deriving the expectation is to estimate it using the *Kalman Filter* (see Appendix D). That is what we have done. From the consequent expected discount rate we have calculated the discrepancy between the actual discount rate and that expectation: to obtain, as it were, an "unanticipated change" in that rate. That represents the innovation to the rate; and it is this which is used to explain, or to track, the innovations to the monetary indicator variables.

Similarly, we can imagine that the bank has some expectation of what the money supply will be given the monetary base (MB) that it has set; and, therefore, some expectation of the short term rate of interest, such as the six month Treasury Bill rate. If there is some discrepancy between its expectation of the monetary base and its actual value, generated of course by its own activities or alteration in the foreign currency reserves, the central bank will seek to reduce or expand the base as necessary. Our estimate of the central bank's expected level of the MB is also derived from application of the Kalman filter (see Appendix D). For Model (1) the three sets of innovations are graphed in Figure (3.7); and the OLS estimates for the innovations to the Sixmtbr are detailed in Table (3.7).

Figure 3.7: Innovations to Sixmtbr, the Discount Rate and the Monetary Base: Model (1).



These variables are all stationary.[14]

The statistics in Table (3.7) provide strong, and statistically significant evidence, in support of associations between the innovations to the short term interest rate in Model (1) and random changes to the two main instruments of monetary control.

Table 3.7: The OLS estimates for the innovations to the Sixmtbr: Model 1(a)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Discrate Innovation(-1)	0.185725	0.096593	1.922764	0.0592
Discrate Innovation(-8)	-0.581090	0.156435	-3.714580	0.0004
Discrate Innovation(-9)	0.590965	0.158952	3.717881	0.0004
Discrate Innovation(-10)	0.598147	0.198359	3.015483	0.0037
Discrate Innovation(-11)	-0.500450	0.186222	-2.687382	0.0093
Discrate Innovation(-12)	-0.420422	0.188357	-2.232044	0.0293
Discrate Innovation(-14)	0.187853	0.063257	2.969673	0.0043
MB Innovation(-5)	-6.993788	2.626848	-2.662425	0.0099
R^2	0.434095	Jarque-Bera: 1.736 [0.420]		
$\overline{R}^2$	0.369156	AR: LM(4), F-stat, 0.68 [0.61]		
S.E. of regression	1.194197	ARCH(4), F-stat, 0.861 [0.493]		
Log likelihood	-105.9009	Hetero: F-stat, 0.834 [0.643]		

[14] ADF unit root tests (no intercepts or trends) for the innovations yield (t-stats in (.) and probability in [.]): Sixmtbr, -8.401 [0.000]; MB, -137.96 [0.000]; and, Discount Rate, -2.173 [0.03].

The matching figures and tables for Model (2) now follow.

Figure 3.8: Innovations to Sixmtbr: Model (2)

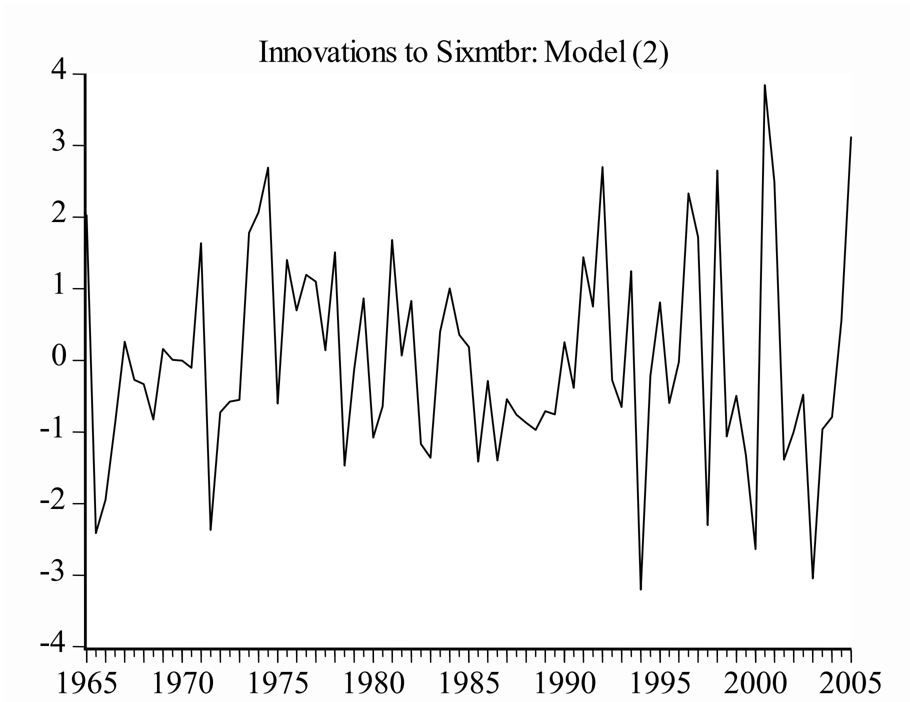


Table 3.8: The OLS estimates for the innovations to the Sixmtbr: Model (2)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Discrate Innovation (-1)	0.194337	0.097362	1.996030	0.0504
Discrate Innovation (-8)	-0.585645	0.157680	-3.714126	0.0004
Discrate Innovation (-9)	0.579730	0.160218	3.618390	0.0006
Discrate Innovation (-10)	0.611912	0.199938	3.060510	0.0033
Discrate Innovation (-11)	-0.460212	0.187705	-2.451789	0.0171
Discrate Innovation (-12)	-0.398890	0.189857	-2.101004	0.0398
Discrate Innovation (-14)	0.175784	0.063761	2.756925	0.0077
MB Innovation (-5)	-6.711733	2.647762	-2.534870	0.0138

R^2	0.415592	Jarque-Bera: 2.03 [0.363]
$\overline{R}^2$	0.348529	AR: LM(4), F-stat., 0.975 [0.428]
S.E. of regression	1.203704	ARCH (4): F-stat., 0.935 [0.45]
Log likelihood	-106.4481	Hetero: F-stat., 0.749 [0.732]

3.6. Summary:

The State Bank of Pakistan considers treasury bills rate as its policy indicator and, therefore, we have used treasury bills' short term interest rate as an appropriate choice in the test VARs. As discussed earlier, we have used two models to test VARs and both models have same responses over the first 10-12 periods following the innovation to the short term interest rate.

The bank lending channel for MTM is playing very important role in Pakistan and our both models empirically confirm that when the tighter monetary policy stance (such a reduction in the monetary base), which has produced an increase in the short term interest rate creates immediate effect to the deposits which goes down which leads to decrease in loans as well and the overall effect of going down these two variables (deposits and loans) declines in investment in the economy that leads to a substantial variation (decrease) in economy but create less impact on inflation.

We have identified long–run cointegrating relationships between loans and deposits in both models, as these variables are considered to have the long-run influences on the banking sector. According to our model (1), the long-run relationships between the short-term interest rate, output, the price level and deposits are all positive. The second long-run relationship is between total bank loans, total deposits, the price level, aggregate output and the relatively riskless banking sector asset, government securites. All associations are positive. On the other hand, in model (2) the first relationship: "private sector" loans are positively related to total deposits and to GDP, and negatively associated with the rate of interest and the price level. From the second relationship, public sector loans, we note: the positive link with total deposits, GDP and also with government securities.

In chapter four and chapter five, we have, further, investigated the portfolio behaviour of Pakistani scheduled commercial banks by using an expected utility model of portfolio composition and safety first principle respectively.

Appendix A: Basic Data

Figure 3.1: Sixmtbr, M, Discrate and MB

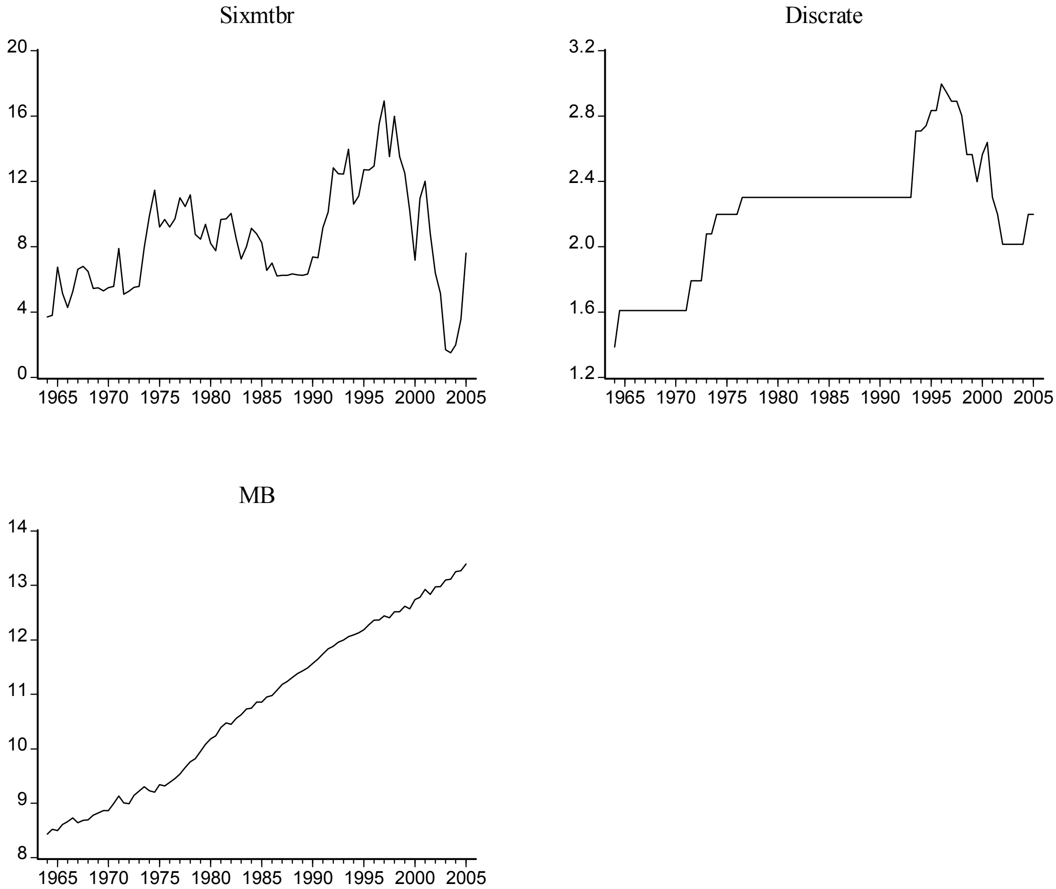


Figure 3.2: TLoans, TLps, TLnps and TDeps

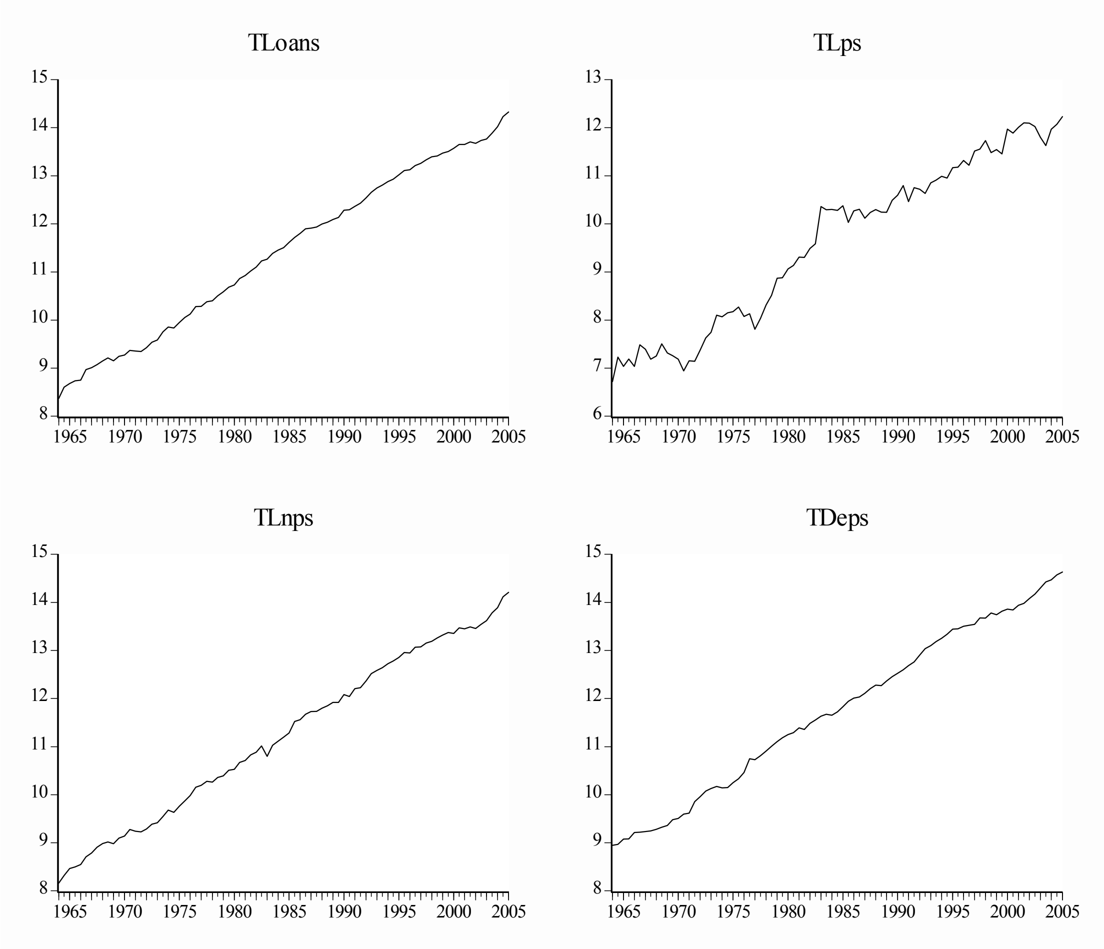
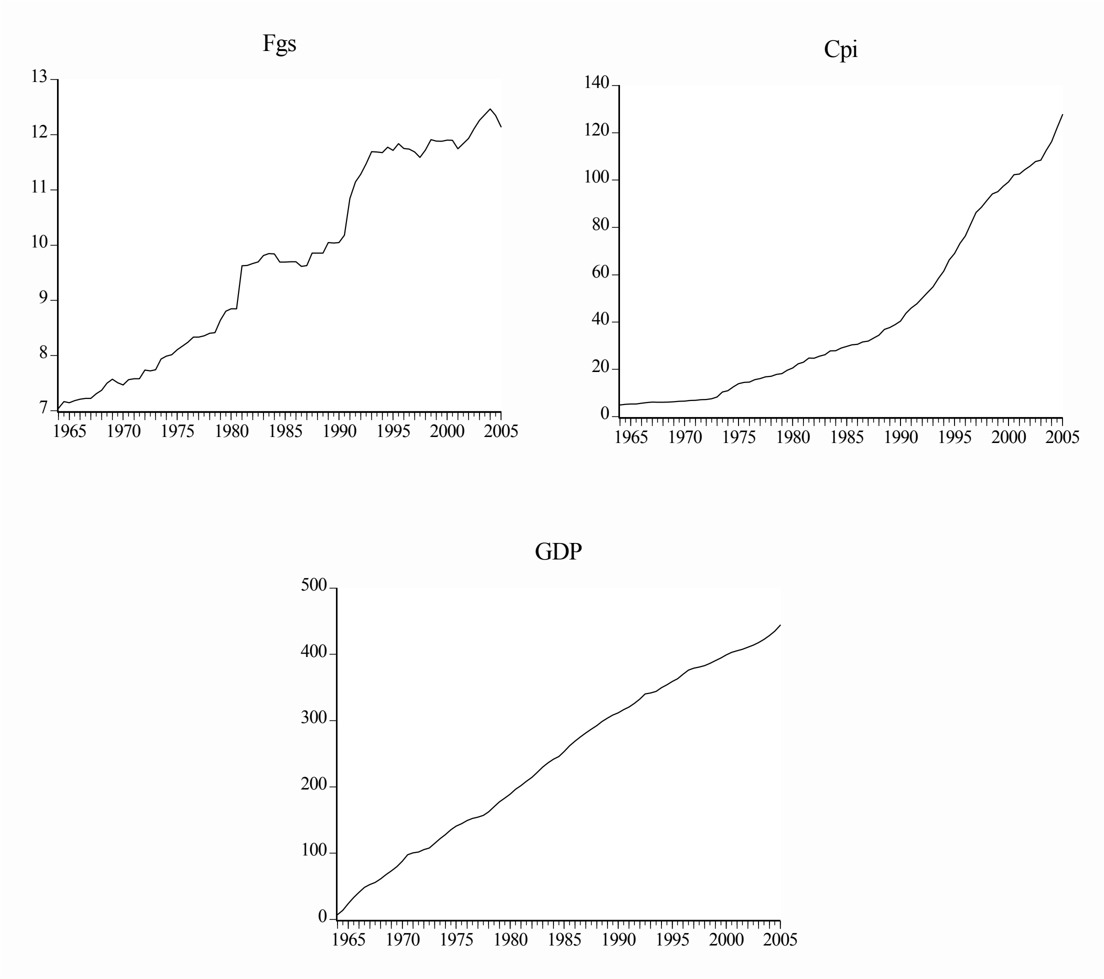


Figure 3.3: Fgs, Cpi and GDP



Appendix B: The diagnostic statistics of the VARs for the 2 models

Model (1):

(1) Lag length: 4 criteria indicate 1 lag; LR indicates 2 lags. Lag 2 is mathematically stable but produces inferior residuals' statistics than lag 1.

(2) Roots of the companion matrix:

Root	*Modulus*
0.968057	0.968057
0.946150	0.946150
0.815947 - 0.180806i	0.835740
0.815947 + 0.180806i	0.835740
0.816420	0.816420
0.707126	0.707126

(3) Residuals:

Equation	*Normal distribution test*	
	J-B statistic	*Kurtosis*
Sixmtbr	2.53 [0.281]	2.32 [0.21]
TLoans	2.23 [0.330]	2.23 [0.15]
Fgs	193.06 [0.00]	0.45 [0.00]
TDeps	11.61 [0.003]	4.28 [0.02]
Cpi	0.05 [0.975]	3.07 [0.90]
GDP	0.97 [0.615]	2.49 [0.34]
Vector	210.5 [0.000]	
	Vector tests	
	AR(4)	*Hetero.*
LM ($\chi^2(36)$)	35.61 [0.487]	
F(294,497)		1.095 [0.189]
χ (294)		338.41 [0.038]

Model (2):

(1) Lag length: 1 lag or 2 lags 1 are each indicated by 2 criteria; the fifth criteria (AIC) indicates lag 7. Only lag 1 is mathematically stable.

(2) Roots of the companion matrix:

Root	Modulus
0.981934	0.981934
0.933602	0.933602
0.827557 - 0.139892i	0.839298
0.827557 + 0.139892i	0.839298
0.787498 - 0.138035i	0.799504
0.787498 + 0.138035i	0.799504
0.506148	0.506148

(3) Residuals:

Equation	*Normal distribution test*	
	J-B statistic	*Kurtosis*
Sixmtbr	2.45 [0.29]	2.32 [0.21]
TLps	6.91 [0.03]	4.23 [0.02]
TLnps	0.57 [0.75]	2.64 [0.51]
Fgs	154.91 [0.00]	8.72 [0.00]
TDeps	6.27 [0.04]	3.74 [0.18]
Cpi	0.35 [0.84]	3.01 [0.98]
GDP	0.94 [0.62]	2.80 [0.72]
Vector	172.4 [0.000]	
	Vector tests	
	AR(4)	*Hetero.*
LM ($\chi^2(49)$)	59.11 [0.153]	
F(448,446)		0.92 [0.80]
χ (448)		472.25 [0.207]

Appendix C: Tests for Cointegration

Table III. 1: Model (1)

Unrestricted Cointegration Rank Test				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.
None *	0.706537	176.3305	95.75366	0.0000
At most 1 *	0.371504	75.79807	69.81889	0.0154
At most 2	0.255370	37.71512	47.85613	0.3146
At most 3	0.087265	13.53598	29.79707	0.8656
At most 4	0.070208	6.048567	15.49471	0.6898
At most 5	0.000969	0.079471	3.841466	0.7780

Table III. 3: Model (2)

Unrestricted Cointegration Rank Test				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.
None *	0.727164	202.6863	125.6154	0.0000
At most 1 *	0.358510	97.47674	95.75366	0.0378
At most 2	0.288483	61.51587	69.81889	0.1917
At most 3	0.225621	33.94707	47.85613	0.5047
At most 4	0.099146	13.23588	29.79707	0.8805
At most 5	0.056551	4.778462	15.49471	0.8319
At most 6	0.000780	0.063211	3.841466	0.8015

Appendix D: Kalman Filter results.

Table IV.1: For the Discount Rate

Convergence achieved after 5 iterations				
	Coefficient	Std. Error	z-Statistic	Prob.
C(1)	-12.29639	1.340626	-9.172125	0.0000
C(3)	2.058809	0.377889	5.448184	0.0000
C(6)	9.937621	3.719876	2.671493	0.0076
	Final State	Root MSE	z-Statistic	Prob.
SV1	27.57328	2.799398	9.849715	0.0000
SV2	199.3043	8.798709	22.65154	0.0000
Log likelihood	-176.8710	Akaike info criterion		4.334240

State Space System

signal equation, *discrate*=0.5*sv1+0.05*sv2+c(1)

state variable, sv1=c(3)**MB*+[var=exp(c(3))]

state variable, sv2=c(6)*sv1(-1) +[var=exp(c(3))]

Table IV.2: For the Monetary Base

Convergence achieved after 1 iteration				
	Coefficient	Std. Error	z-Statistic	Prob.
C(3)	-16.90918	0.002080	-8127.739	0.0000
C(4)	-0.000333	2.25E-06	-147.6319	0.0000
	Final State	Root MSE	z-Statistic	Prob.
SV1	0.047200	0.000301	157.0274	0.0000
SV2	-0.793679	0.003588	-221.2196	0.0000
Log likelihood	88.06053	Akaike info criterion		-2.073748

State Space System

signal equation, MB=sv1+c(3)*sv2

state variable, sv1=sv1(-1)+c(4)*sv2(-1)+[var=exp(c(3))]

state variable, sv2=c(3)*sv1(-1)

CHAPTER FOUR

BANK PORTFOLIO BEHAVIOR UNDER RISK AVERSION: THE EXPECTED UTILITY APPROACH

4.1: Introduction

The expected utility model, commonly reduced to the mean –variance model, of bank portfolio behavior under risk stems from Hicks (1935), Tobin's (1958) and Markowitz's (1952, 1959) as noted in chapter two. According to this approach, the determinants of alternative portfolios can be assessed by the trade-off between their expected return and valuations risk, where the former is the mean of the probability distribution of return and the latter is usually approximated by the variance of that distribution.

In this chapter we test a number of static as well as dynamic models of the portfolio behaviour of Pakistani banks. The underlying static relationship is derived using the mean-variance expected utility, and dynamics are introduced through the application of the general stock adjustment process first propounded by Brainard and Tobin (1968). As noted in chapter two, prominent empirical work on commercial bank portfolio behaviour can be seen in Kane and Malkiel (1965), Perkin (1970), Parkin, Gray and Barrett (1970), Courakis (1974,1975,1980,1988), Klein (1971), Pyle(1971),Sharp (1974), White(1975), Bewley (1981),Hart and Jaffee (1974), Sealey (1980), Fan (1991), Subeniotis (1991), Arjoon (1994), Kagigi, Ford and Cadle (1994, 2001) and Wibowo (2005). The structure of the dynamic model enables us to examine the responses over time of the "choice" assets to alterations to a set of exogenous variables that include policy –determined (central bank determined) or at least policy-influenced factors. In effect, we can derive multiplier effects and their time-profiles induced by changes to the banks' investment environment.

The rest of the chapter is organised as follows. As background to our formal modelling and econometric analysis, the Section 4.2 presents the structure of the static and dynamic portfolio models and gives details of the impact, interim and total multiplier effects. Section 4.3 discusses specification of the model, gives details of the econometric methodology employed and also provides the data analysis. The statistical results, including the multiplier effects, are presented and evaluated in Section 4.4. But in section 4.5 ,we estimate the best aggregated dynamic model, where all loans has been aggregated into one, and provide the comparison between the best disaggregated and best aggregated models. Section 4.6 provides the summary of the chapter.

4.2: Theoretical Framework of Expected Utility Approach:

We have developed a model of asset/ liability choice, which is based on the stochastic nature of asset return and borrowing cost, along the lines of those in the literature which are derivatives of Parkin-Gray-Barrett model (1970).

Assume that a bank possesses the following static utility function over profits (π); which are stochastic and normally distributed[1].

[1] We utilize the exponential function given the dubious properties of the quadratic utility function (See, amongst others, Feldstein, 1969)

(4.1) $U = a - \gamma \ e^{-b\pi}$ [2]

Where, U = Utility per decision period, π = Real profit per decision period and *a, b* and γ are parameters ($b, \gamma > 0$)

By taking expectation of (4.1), we have

(4.2) $E(U) = a - \gamma \ e^{-b(U_\pi - 0.5b\sigma^2)}$

where U_π and σ^2 mean and variance of profit[3]. Hence , to maximise expected utility of profit the bank effectively maximises:

(4.3) $W = U_\pi - 0.5b\sigma^2$

That is the certainty –equivalent of the profit that is to be chosen[4].

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[2] The exponential utility function has proved to be a popular function ever since it was introduced into this type of literature by Freund (1956).

[3] (4.2) follows from the fact that E ($e^{t\pi}$) is moment $M_\pi(t)$ generating function (MGF) of a normally distributed variable, with t set at –b: $M_\pi(t) = a - \gamma \ e^{-b(U_\pi - 0.5b\sigma^2)}$

[4] The parameter of *b* is the degree of risk aversion in the sense of Arrow and Pratt (see, Pratt (1964) and Arrow (1965)).The exponential utility function used is one of the HARA class functions as noted by Merton (1971). Arrow-Pratt absolute risk aversion is defined as:

(i) $ARA = \dfrac{-U''(\pi)}{U'(\pi)}$

Relative risk aversion.

(ii) $ARA = \dfrac{-U''(\pi)\pi}{U'(\pi)}$

We come now to the definition of profit:

$$(4.4)\quad \pi = r'\upsilon \equiv \begin{bmatrix} r_1' & \vdots & r_2' \end{bmatrix} \begin{bmatrix} A_1 \\ A_2 \end{bmatrix}$$

Where r' is a $(1\times k)$ row vector of yields (returns) on assets and borrowing rates (costs) on liabilities. υ is a $(1\times k)$ column vector of assets and liabilities (where the liabilities are measured negatively. A_1 is a $(1\times n)$ column vector of endogenous variables refers to "choice" assets or liabilities of balance sheet items and A_2 $(1\times k)$ refers to the column of non-choice assets and liabilities of balance sheet items (exogenous variables). Hence:

$$(4.5)\quad E(\pi) \equiv U_\pi = e'\upsilon = \begin{bmatrix} e_1' & \vdots & e_2' \end{bmatrix} \begin{bmatrix} A_1 \\ \hat{A}_2 \end{bmatrix}$$

Where as e_1' is a $(1\times n)$ vector of expected rate of return/cost on the choice set items and e_2' is a $(1\times k)$ vector of return/ cost on non- choice set items. $\hat{A}_2$ is the expected value of the exogenous non choice items. From (4.3) to (4.5); where Ω is the variance-covariance matrix of the asset/ liability returns/costs, we have

$$(4.6)\quad W = \begin{bmatrix} e_1' & \vdots & e_2' \end{bmatrix} \begin{bmatrix} A_1 \\ \hat{A}_2 \end{bmatrix} - 0.5b \begin{bmatrix} A_1' & \vdots & \hat{A}_2' \end{bmatrix} \Omega \begin{bmatrix} A_1 \\ \hat{A}_2 \end{bmatrix}$$

We can imagine that equation (4.6) applies to the "representative" bank, so that aggregation across a given banking group merely results in the assets and liabilities in equation (4.6) being multiplied by the number of banks. The bank will choose the vector

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Thus, the expected utility function reflects constant absolute but increasing relative risk-aversion.

A_1 to maximize W subject to the balance sheet constraint. That constraint is of equality according to which in bank portfolio, sum of assets must equal the sum of liabilities at any time.

(4.7) $0 \equiv i_1' A_1 + i_2' \hat{A}_2$

Where as i' is a row unit vector. The liabilities are treated with (–ve) sign. In particular environment, the selection A_1 might be constrained by other factors. For example, its cash element might be subject to a minimum required ratio to total deposits, imposed by the central bank. In this scenario, should that ratio be binding and effective in the Kuhn-Tucker sense, the variable concerned will, as it were, constitute its "own" portfolio. Thus, if cash always equals the constraint of α times total deposits, then, cash is effectively predetermined; and so that the elements in A_1 are chosen subject to deposits in A_2 being equal to (1- α) of the total deposits. Effectively, the balance sheet constraint, equation (4.7), is re-written; so that the sum of the non-cash choice items must equal (1- α) of total liabilities.

Suppose that A_1 has a (n×1) and $\hat{A}_2$ has (k×1) vectors, we can partition the variance-covariance matrix.

(4.8) $\Omega = \begin{bmatrix} \Omega_{11} & \vdots & \Omega_{12} \\ \cdots & & \cdots \\ \Omega_{21} & \vdots & \Omega_{22} \end{bmatrix}$

Ω_{11} is a (n×n) symmetric variance covariance matrix of the choice set items, return/ cost; Ω_{22} is a (k×k) symmetric variance and covariance matrix of non-choice set items' return/ cost; Ω_{12} is (n×k); Ω_{21} is (k×n); and Ω_{21} = Ω_{12} is a (nxk) covariance matrix of the choice non-choice set return and cost. Where n is number of endogenous variables and k is number of exogenous variables (includes interest rate and liabilities). We have now generally defined Ω under the assumption that the yields on endogenous and exogenous variables themselves are stochastic.

Now, substituting equation (4.8) into equation (4.6), the bank chooses the vector A_1 to maximize the resultant expression subject to the budget constraint, equation (4.7). In effect, to maximize this Lagrangean expression:

$$(4.9)\quad W = \begin{bmatrix} e_1' & \vdots & e_2' \end{bmatrix} \begin{bmatrix} A_1 \\ \hat{A}_2 \end{bmatrix} - 0.5b \begin{bmatrix} A_1' & \vdots & \hat{A}_2' \end{bmatrix} \begin{bmatrix} \Omega_{11} & \vdots & \Omega_{12} \\ \cdots & & \cdots \\ \Omega_{21} & \vdots & \Omega_{22} \end{bmatrix} \begin{bmatrix} A_1 \\ \hat{A}_2 \end{bmatrix} + \lambda(i_1' A_1 + i_2' \hat{A}_2)$$

The λ is an undetermined Lagrange multiplier on the budget constraint Partial differentiation of equation (4.9) with respect to A_1 and λ produces these first-order conditions for a maximum value of expected utility:

$$(4.10)\quad -b\Omega_{11}A_1 + \lambda i_1 = -e_1 + b\Omega_{12}\hat{A}_2$$

$$(4.11)\quad i_1' A_1 \qquad = -i_2' \hat{A}_2$$

We note that in equation (4.10) e_1 is a $(n\times1)$ vector, Ω_{11} is $(n\times n)$ and A_1 is $(n\times1)$, i_1 and i_2 are $(n\times1)$ and $(k\times1)$ unit vectors respectively from above two equations. From equations, (4.10) and (4.11), we can deduce that

$$(4.12)\quad \begin{bmatrix} A_1 \\ \lambda \end{bmatrix} = \begin{bmatrix} b\Omega_{11} & \vdots & -i_1 \\ -i_1' & \vdots & \ddot{0} \end{bmatrix}^{-1} \begin{bmatrix} e_1 - b\Omega_{12}\hat{A}_2 \\ i_1' \hat{A}_2 \end{bmatrix} = \begin{bmatrix} \Sigma_{11} & \Sigma_{12} \\ \Sigma_{21} & \Sigma_{22} \end{bmatrix} \begin{bmatrix} e_1 - b\Omega_{12}\hat{A}_2 \\ i_1' \hat{A}_2 \end{bmatrix}$$

We are only interested in Σ_{11} and Σ_{12} as we have to see the impact of profits/costs vector on the endogenous variables. By applying standard technique for inversion of partitioned matrices (see Hadley 1964), we can find the values of Σ_{11} and Σ_{12} respectively.

(4.13) $\sum_{11} = (-b\Omega_{11})^{-1}[I + i_1(i_1^{'}(-b\Omega_{11})^{-1}i_1)^{-1}i_1^{'}(-b\Omega_{11})^{-1}]; \;\; \sum_{11} = nxn$

(4.14) $\sum_{12} = (-b\Omega_{11})^{-1}i_1(i_1^{'}(-b\Omega_{11})^{-1}i_1)^{-1}; \;\; \sum_{12} = nx1$

So, the impact of returns/costs vector on the endogenous variables is given by:

(4.15) $(-b\Omega_{11})^{-1}[I + i_1(i_1^{'}(-b\Omega_{11})^{-1}i_1)^{-1}i_1^{'}(-b\Omega_{11})^{-1}] \; e_1$

The matrix Σ_{11} on the rates of return/cost vector must be symmetric, which follows from the fact that all the matrices in (Σ_{11})[5] are symmetric. This matrix must also have column sums of zero; which is Cournot Aggregation condition on the vector e_1 (this can be proved by pre-multiplying (Σ_{11}) by $i_1^{'}$ in the footnote 5).

The Engel Aggregation condition follows immediately, since in addition:

(4.16) $i_1^{'}\sum_{12} = i_1^{'}(-b\Omega_{11})^{-1}i_1(i_1^{'}(-b\Omega_{11})^{-1}i_1)^{-1} = \dfrac{i_1^{'}(-b\Omega_{11})^{-1}i_1}{i_1^{'}(-b\Omega_{11})^{-1}i_1} = 1$

Further, it can be shown that Σ_{11} is symmetric[6].

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[5] We can re-write equation (4.13) as:

$$\sum_{11} = (-b\Omega_{11})^{-1}\left[\frac{i_1^{'}(-b\Omega_{11})^{-1}i_1 + i_1 i_1^{'}(-b\Omega_{11})^{-1}}{i_1^{'}(-b\Omega_{11})^{-1}i_1}\right]$$ given that $(i_1^{'}(-b\Omega_{11})^{-1}i_1)$ is a scalar.

[6] That is, $\sum_{11}^{'} = \sum_{11}$. This can be proved by taking the transpose of $\sum_{11}$ in footnote 5, since these $(i_1^{'}(-b\Omega_{11})^{-1}i_1)$ is a scalar

Thus, we can write the (static) equation system in this general format[7] according to which demand for assets depends on actual rates of return for the decision period and the level of exogenous variable.

(4.17) $A_{1,t} = g\ e_{1,t} + \vartheta\ \hat{A}_{2,t} + \varepsilon_t$

Where g is $(n\times n)$; ϑ is $(n\times k)$; $e_{1,t}$ is a $(n\times 1)$ and $\hat{A}_2$ is a $(k\times 1)$. g and ϑ are the response matrices of the actual rates of return and the actual liabilities/ exogenous variables respectively. Here we have included the time subscripts and the ε_t vector of disturbance terms are normally distributed with mean vector zero and constant variance $\sigma^2 I$. The elements of the matrices g and ϑ are the parameters that have to be estimated and a set of restrictions, as discussed above, can be imposed on them.

(a) $g_{ij} = g_{ji}$ *(Symmetric)*

(b) $i_1^{'} g = 0$ *(Cournot Aggregation)*

(c) $i_1^{'} \vartheta = -i_1$ *(Engel Aggregation)*

When (a) and (b) conditions hold the system of demand equation is homogeneous of degree zero in the vector of asset returns, since this constraint must then be satisfied:

(d) $i_1^{'} g^{'} = \widehat{0}$ *(Homogeniety)*

The second order condition for a maximum of expected utility is that the Hessian matrix:

(4.18) $\begin{bmatrix} -b\Omega_{11} & i_1 \\ i_1^{'} & 0 \end{bmatrix}$

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[7] $g = \Sigma_{11}$, $H = \Sigma_{12}$ therefore, $\vartheta = Hi_{\omega}^{'} - \rho b\Omega_{12}$

must have principal minors that alternate in sign beginning positive (since we have one constraint). The selected vector of endogenous assets then maximizes expected utility. So, the volume of an asset will never decrease, if the rate of the interest on that asset increases (ceteris paribus). Similarly, should the rate on liability increase, the holdings of that liability will fall (liabilities are measured (-ve) sign)[8].

$$(4.19) \quad g_{ii} \leq 0, \ \forall \ \hat{A}_2$$

$$(4.20) \quad g_{ii} \geq 0, \ \forall \ A_1$$

Equation (4.17) represents the static model, which shows the bank optimal demand functions that represent the institutions long-run equilibrium solutions, when neither transactions cost nor market deficiencies deter the banking institution. It is assumed that banks take a decision at the beginning of the period and this decision is independent of the changes in the non-choice items during the period. This assumption is only consistent in the absence of transaction costs in the static nature of the model. The bank will continuously adjust its portfolio towards the optimal static position in the absence of transaction costs and market deficiencies. But in real world, portfolio adjustment towards the optimal static position is not possible due to the existence of transaction cost and

[8] MaLarren and Upcher (1986) have shown empirically that, for the maximizing of the bank's profit, the yield elasticity on liabilities' supply should be negative and the yield elasticity on assets' demand should be positive. That is a necessary (but not sufficient) condition.

market deficiencies[9]. Equivalently, the allocation of bank's available funds (non-choice items) at the end of the decision period may not be the desired or optimal level of choice assets. Therefore, there is the requirement of the specification of a mechanism for the bank's adjustment process from the beginning of period optimal position to a new one when incurs transaction cost, market deficiencies and changes in the non-choice items. That mechanism, then, translates the desired level of choice assets into its actual level. Such adjustment procedure was introduced by the Brainard and Tobin (1968), enabled the bank's short run demand functions to be derived.

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[9] A bank has to incur adjustment costs when it adjusts its actual portfolio towards the optimal position. For example, the process of buying and selling securities include cost in the shape of commission and capital loss. Similarly, the more frequently a bank adjusts it portfolio, the more generate transaction costs it has to bear. For example, banks advances usually committed for a certain period of time. If a bank wishes to reduce its stock of advances before the agreed repayment is due it will increase additional costs in terms of damaging future customer relationship and/or explicit financial penalties for breaking an agreement. There is positive transaction cost involved either increasing or decreasing the holding of an asset. Sharp (1973& 1974) specified a model based on both utility maximization and total cost minimization that overcame the residual method of satisfying the balance sheet constraints. In his specification, he was encompassing the entire list of interest rates of the endogenous assets/liabilities in each and every demand function and taking into account a general stock adjustment mechanism so that the adjustment of any one asset was to be dependent on the deviations from desired levels of all endogenous choice items.

(4.21) $\Delta A_{1,t} = A_{1,t} - A_{1,t-1} = L(A_{1,t}^{d} - A_{1,t-1}) + \varepsilon_t$

Where $\Delta A_{1,t}$ is (1x*n*) vector of actual change in choice set item from time *t*-1 to time *t* period. $(A_{1,t}^{d} - A_{1,t-1})$ represents a (*n*x1) vector of difference between desired and actual holdings of choice set items. These differences generate the previously mentioned changes in actual holdings of choice set items through the (*n*x*n*) *L* response matrix. Therefore, the matrix *L* is a matrix of speeds of adjustments of the actual to the desired levels of the choice items in the portfolio. So, above equation states that the actual changes in the holding of any choice set item represents an adjustment from its actual to its desired level. $A_{1,t}^{d}$ is the desired (optimal) vector of endogenous assets, which is identical with the left-hand side of equation of (4.17) (omitting its error term).When the latter expression is substituted in equation (4.21), we discover after some rearranging of terms that:

(4.22) $A_{1,t} = Lg\ e_{1,t} + L\vartheta\ \hat{A}_{2,t} + (I - L)A_{1,t-1} + \varepsilon_t = Ke_t + X\,\hat{A}_{2,t} + ZA_{1,t-1} + \varepsilon_t$

Where $Lg = K$, $L\ \vartheta = X$ and $(I- L) = Z$

$A_{1,t-1}$, g, $\hat{A}_{2,t}$ and ϑ are defined above with respect to the static system equation. *I* is the identity matrix and $A_{1,t-1}$, is an *n* component vector of lagged endogenous (choice set) items, and ε_t is disturbance term. Similarly to the earlier model, the balance sheet constraint has its impact on the response matrices of this dynamic version of the demand function. The constraints on the parameters contained in *g* and ϑ are identical to those of the static model. As *g* is a symmetric matrix, we have no reason to believe that *L* is also symmetric. But, even we assume that *L* is symmetric, the product of two symmetric matrices is not necessarily symmetric matrix. Therefore symmetry must not be applied to matrix K. As for as X and Z matrices are concerned, their properties depend also on the characteristics of the L matrix. Additionally, we have the following condition on the matrix of lagged responses:

(4.23) $i'Z = 0$

This is the Cournot Aggregation condition implied by the balance sheet equation[10].

4.2.1: Impact, Interim and Total Multipliers:

After estimating a dynamic equation (4.22), we will calculate the multiplier effects of the choice assets to unit changes to the non-choice items. For example, all interest rates with minimum and maximum limits within the economy are set by the SBP (the central bank of Pakistan), some of these can be taken as direct policy instruments: for example, it might be a CMR (using as a proxy for the discount rates). The multiplier effects are of

[10] See Ford (1991).According to Brainard and Tobin (1968) in equation (4.22), matrix L should satisfy Cournot aggregation condition that is, L should possess columns (of adjustment coefficients) that sum to zero as they thought the argument of the balance sheet constraint would not be satisfied until and unless the matrix L has column sums of zero.

Landenson (1971, 1973) and Clinton (1973) challenged the above claim of Brainard and Tobin. They claimed that the matrix (I- L) in equation (4.22) should have columns that sums to zero instead of matrix L (which is Cournot Aggregation condition) and the matrix L must have column sum of unity (which is Engel Aggregation condition). White (1975) concurred this argument.

three kinds: impact (current); interim (ensuing periods); and total (cumulative) multipliers.

The multiplier effects are indispensable for an overall evaluation of the role of banks in policy implementation, and will drive these effects as follows:

$$A_{1,t} = Lg\ e_{1,t} + L\vartheta\ \hat{A}_{2,t} + (I-L)A_{1,t-1} + \varepsilon_t = Ke_t + X\,\hat{A}_{2,t} + ZA_{1,t-1} + \varepsilon_t$$

By setting $\begin{bmatrix} K & X \end{bmatrix} = \Phi$, and $\begin{bmatrix} e \\ \hat{A}_2 \end{bmatrix} = x_t$

Equation (4.22) can be written as,

(4.24) $\quad A_{1,t} = \Phi x_t + ZA_{1,t-1} + \varepsilon_t$

Where Φ is the matrix of the impact effects (current period) of the exogenous variables.

Then, to drive the indirect effects, as they are distributed over the later periods, we lag equation (4.24) and substitute them it for endogenous variable $A_{1,t-1}$. After repeating the substitution g times (Theil, 1971), we have:

(4.25) $\quad A_{1,t} = Z^2 A_{1,t-1} + \Phi x_t + Z\Phi x_{t-1} + Z\varepsilon_{t-1} + \varepsilon_t$

(4.26) $\quad A_{1,t} = Z^{2(g+1)} A_{1,(t-g-1)} + \Phi x_t + Z\Phi x_{t-1} + Z(Z\Phi)x_{t-1} + Z^2(Z\Phi)x_{t-1} + ... + Z^{(g-1)}(Z\Phi)x_{t-g} + \varepsilon_t$
$\quad + Z\varepsilon_{t-1} + Z\varepsilon_{t-2} + ... + Z^g \varepsilon_{t-g}$

Then assuming that Z converges to a null matrix, that is, its eigenvalues are less than one in absolute value as $g \rightarrow \infty$ the first term on the right hand side of equation (4.26) also converges to a null matrix and, therefore, we may express that equation as:

(4.27) $\quad A_{1,t} = \Phi x_t + \sum_{g=1}^{\infty} Z^{g-1}(Z\Phi)x_{t-g} + \sum_{g=0}^{\infty} Z^g \varepsilon_{t-g}$

This is the final form of the equation system (4.22)[11]. The successive response matrices are, with the first being (as noted above) the impact multiplier effects, the remainder being the interim multiplier effects over time:

(4.28) $\Phi, (Z\Phi), Z(Z\Phi), Z^2(Z\Phi), ..., Z^n(Z\Phi)$

While, the total response matrix G is:

(4.29) $G = \Phi + (Z\Phi)\sum_{g=0}^{\infty} Z^g = (I - Z)^{-1}\Phi$

The time-profiles of the multiplier effects for any given endogenous variable will depend upon the roots of the Z matrix. If some of the roots are complex numbers then the variables will exhibit a cyclical path to the steady state.

4.3: Specification of the Models, Methodology and Data Analysis:

Equations (4.17) and (4.22) represent static and dynamic models, respectively, for the portfolio behaviour of an individual bank. To estimate these models we have to use the same definitions of choice *(A_1)* and non choice *(A_2)* items in table (4.3.1) and make the following assumptions regarding aggregation over banks. We assume that

- All banks possess the same decision period and maximize the same objective function, i.e, $W = U_\pi - 0.5b\sigma^2$
- Future expectations of assets' rate of returns and the subjective variance-covariance matrix are identical for all banks.
- The same transaction and disequilibrium costs coefficients are faced by all banks.

[11] See Theil and Boot (1962) and Theil (1971)

Accordingly, we may sum over the *n* commercial banks of Pakistan and use consolidated balance sheet data. In order to estimate static and dynamic equations (4.17) and (4.22), we require one more assumption. The vector of expected rate of return on the choice variables, $e_{1,t}$, and the expected values of the non choice variables , $\hat{A}_{2,t}$, are unobservable. Consequently, we approximate the expected rate of return $e_{1,t}$ of choice items by the semi-annual actual rates $r_{1,t}$ [12] and replace the expected values of the non-choice items $\hat{A}_{2,t}$ by their actual values $A_{2,t}$. In consideration of the above, we can write equations (4.17) and (4.22) for all banks under consideration as:

(4.30) $A_{1,t} = g\ r_{1,t} + \vartheta\ A_{2,t} + \varepsilon_t$

(4.31) $A_{1,t} = Kr_{1,t} + X\ A_{2,t} + ZA_{1,t-1} + \varepsilon_t$

Parkin *at el* (1970) include the error term in the demand equation by anticipating that actual and optimal levels of the choice items deviate by a factor ε which is a vector of normally distributed random errors with mean zero. Berndt, McCurdy and Rose (1980) argue the introduction of the error term ε in the static demand equation – which is assumed to be independent of the explanatory variables. They prove that the error term ε is a composite disturbance vector of endogenous and exogenous variables and it is correlated with two vectors of explanatory variables i.e, in our case these are $e_{1,t}$ and

[12] As the returns on some of the assets/liabilities are known at a given time, and are fixed by the banks or do not change much over the one-period decision (such as Federal Govt securities, Tbills etc).

$\hat{A}_{2_t}$. According to them, any error in the demand equation of an individual bank cannot be assumed to be independent of the explanatory variables which mean that there could be a possibility of autocorrelation. (4.30) and (4.31) equations represent static and dynamic equations in this chapter. We assume that both error terms in the above equations are independent of the other stochastic components in the models and are thus independent of the explanatory variables in the regression equations. It should be noted that assuming error terms for both the static and dynamic model is theoretically inconsistent. If the static model specification is correct, then the dynamic model is incorrect, or at least redundant. Conversely, the dynamic model is the appropriate specification if the static model is misspecified.

One of the important assumptions made in the mean-variance model is that the portfolio return is normally distributed. This assumption is only satisfied if the returns of all items are normally distributed. We have checked the normality of the each return by looking Jarque-Bera statistics and Kernel Density graphs and standard EDF tests, and found that all interest rates are normally distributed except for inflation where there were some outliers. But inflation is approximate normally distributed. So for given assets and liabilities at any one time; profit is "more or less" normally distributed.

4.3.1: Methodology, Data and Their Properties:

Full Information Maximum Likelihood (FIML) technique [13] is employed for the estimation of the coefficients of the system's equations. FIML is being used because whether the static or the dynamic system is estimated, one of the equations must be deleted from the system, and without losing any information. The complete system (4.31) is singular and *n-1* of the *n* equations can be estimated independently and the *nth* equation can be estimated by using the balance sheet constraints as mentioned in equation (b) and (c) respectively. If the system is estimated by *SUR*, the estimates depend upon which equation is omitted to avoid singularity.

The exogenous and endogenous scalar variables are detailed in table 4.3.1, which repeats table 2.2.2 for convenience

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[13] Barten (1969) proved that under FIML it does not matter which equation is omitted, as it is possible to estimate the coefficients of deleted equation indirectly by imposing restrictions of Cournot and Engel aggregation respectively. He also explained even when restrictions are imposed on the matrices of coefficients; FIML estimates the likelihood function under the assumption that the contemporaneous errors have a joint normal distribution. Provided that the likelihood function is correctly specified, in general, FIML estimators are consistent, asymptotically efficient, asymptotically normally distributed. Another advantage of FIML is that tests of parameter restrictions can be effected by likelihood ratio.

Table 4.3.1: Choice and Non Choice Items of the Pakistani Banks

Notation	*Status*	*Description*
Panel A : Balance Sheet		
Assets		
GOVTS	*Endogenous*	*Loans to the Govt.Sector*
PUBS	*Endogenous*	*Loans to the Public Sector*
PRIVS	*Endogenous*	*Loans to the Private Sector*
PERS	*Endogenous*	*Loans to the Personal Sector*
OTHERS	*Endogenous*	*Loans to the Others Sector*
TRUST	*Endogenous*	*Loans to the Trust Funds & Non-Profit Org.*
PGS	*Exogenous*	*Provincial Govt. Securities*
SUMB	*Endogenous*	*Borrowing from, SBP*
FGS	*Endogenous*	*Federal Govt. Securities (Bonds)*
TBILLS	*Endogenous*	*Treasury Bills*
CASH	*Endogenous*	*Cash*
Liabilities		
CAPITAL	*Exogenous*	*Capital*
RESERVE	*Exogenous*	*Reserve*
CAPRES	*Exogenous*	*Capital & Reserve*
TTD	*Exogenous*	*Total Time Deposit*
TDD	*Exogenous*	*Total Demand deposits*
TDTL	*Exogenous*	*Total Demand and Time Deposit*
Panel B: Rates of Return on the Asset		
WAG	*Exogenous*	*Warra (weighted average rate of return) Govt. Sector*
WAP	*Exogenous*	*Warra Public Sector*
WAPR	*Exogenous*	*Warra Private Sector*
WAPL	*Exogenous*	*Warra Personal Sector*
WAOH	*Exogenous*	*Warra Other Sector*
WAT	*Exogenous*	*Warra Trust Funds & Non-Profit Org.*
PGR	*Exogenous*	*Provincial Govt. Securities Rates*
CMR	*Exogenous*	*Call Money Rates—proxy for discount rates*
GBYLD	*Exogenous*	*Govt. Bond Yield*
SIXMTBR	*Exogenous*	*Six Month Treasury Bills Rates*
INFLN	*Exogenous*	*Inflation (Consumer Price Index)*

Due to the existence of non-stationarity among endogenous/exogenous variables, one alternative is to estimate the system (static or dynamic) in *ratio* forms. We adopt that approach and divide the assets and liabilities of the balance sheet by the total liabilities (total deposits and liabilities, borrowings, capital and reserve).

In order to avoid spurious regression, we still need to conduct unit root tests, first to ensure that the ratios are I(0). If a variable contains a unit root, is I(1), then it is non-stationary and regression involving the series can falsely imply the existence of a meaningful economic relationship (Phillips, 1986). There are several ways of testing for the existence of a unit root. Here we use augmented Dickey-Fuller (ADF), Philips-Perron and Perron's (1997) unit root tests to test the null hypothesis that a series contains a unit root. Both tests confirm (in tables 4.3.2 and 4.3.3) that all endogenous and exogenous variables, including the interest rate variables, are I(0) processes.

4.3.2: Unit Root Tests: Endogenous Variables (Asset/Liability Ratios)

Ratio	*Unit root tests: t-statistics and probabilities*
	ADF
GOVTS	*-3.891887 (0.0032)*
PRIVS	*-3.564245 (0.0086)*
OTHERS	*-3.087933 (0.0314)*
SUMB	*-3.964685 (0.0026)*
TBILLS	*-3.837104 (0.0195)*
CASH	*-3.888555 (0.0169)*
	Phillips-Perron
PUBS	*-2.965866 (0.0424)*
PERS	*-3.916092 (0.0030)*
FGS	*-2.722452 (0.0746)*
	Perron: Structural Break test
TRUST	*Model I01, all methods: -10.88(0.00)* *Model I02, all methods: -10.80(0.00)* *I(0), with a break at 19971s1*

Unit Root Tests: Endogenous Variables (Asset/Liability Ratios): Continued

Ratio	*Unit root tests: t-statistics and probabilities*
	ADF
PGS	*-1.626239(0.0977)*
CAPRES	*-2.781050(0.02088)*
TTD	*-3.248369 (0.0828)*
TDD	*-2.641040(0.0892)*

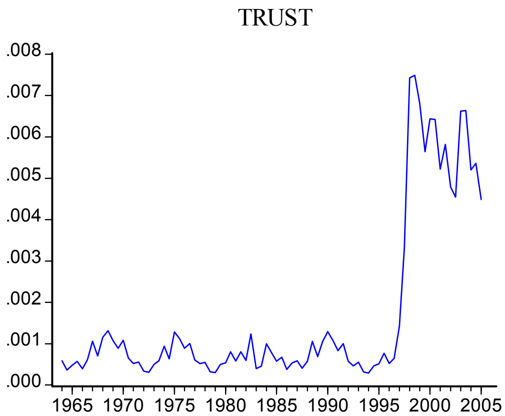
4.3.3: Unit Root Tests: Interest Rates

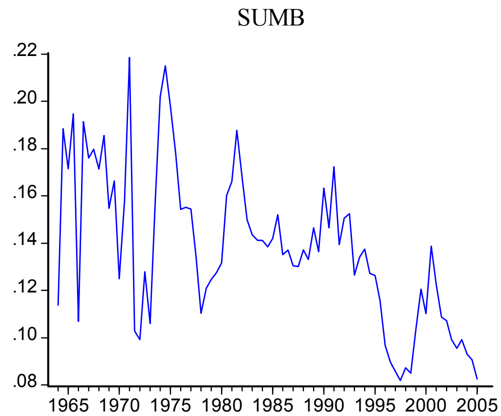
Interest Rate	*Unit root tests: t-statistics and probabilities*
	ADF
WAG	*-2.918181(0.0475)*
WAP	*-2.53299(0.01115)*
WAPR	*-2.67320(0.0830)*
WAPL	*-2.694007(0.0793)*
WAOH	*-2.91783(0.0476)*
CMR	*-3.845811(0.0037)*
GBYLD	*-2.615113(0.0945)*
SIXMTBR	*-2.657966(0.0860)*
INFL	*-3.570551(0.0085)*
	Phillips-Perron
WAT	*-2.689217(0.0802)*

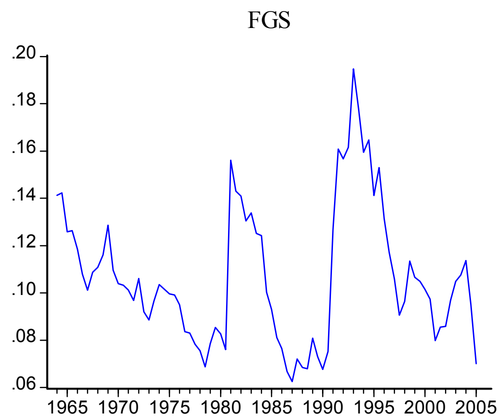
Further graphic presentation of endogenous and exogenous variables is given below in figures 4.3.1.

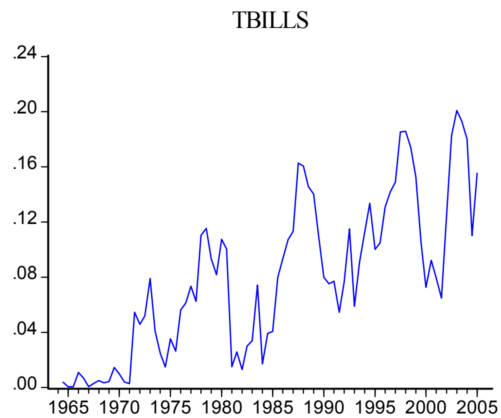
Figures (a): Endogenous variable (in Ratios: Rupees in Millions)

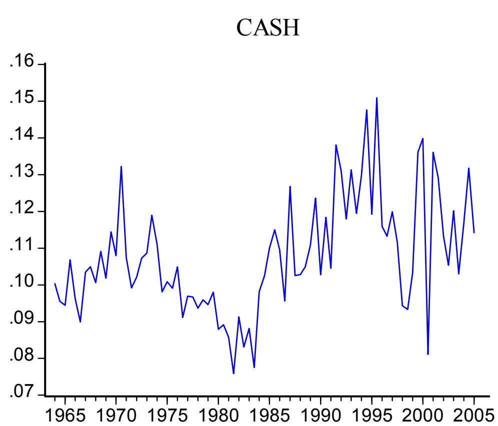
Endogenous variable (in Ratios: Rupees in Millions): Continued



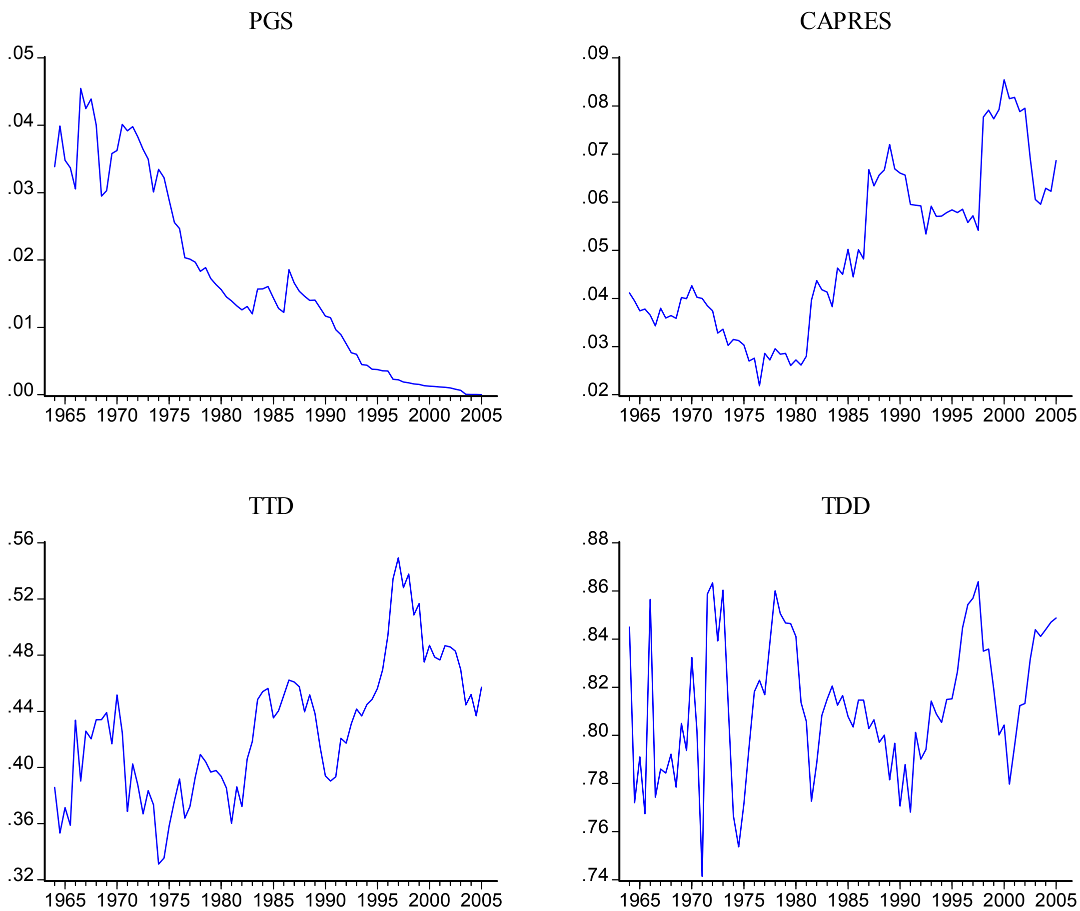




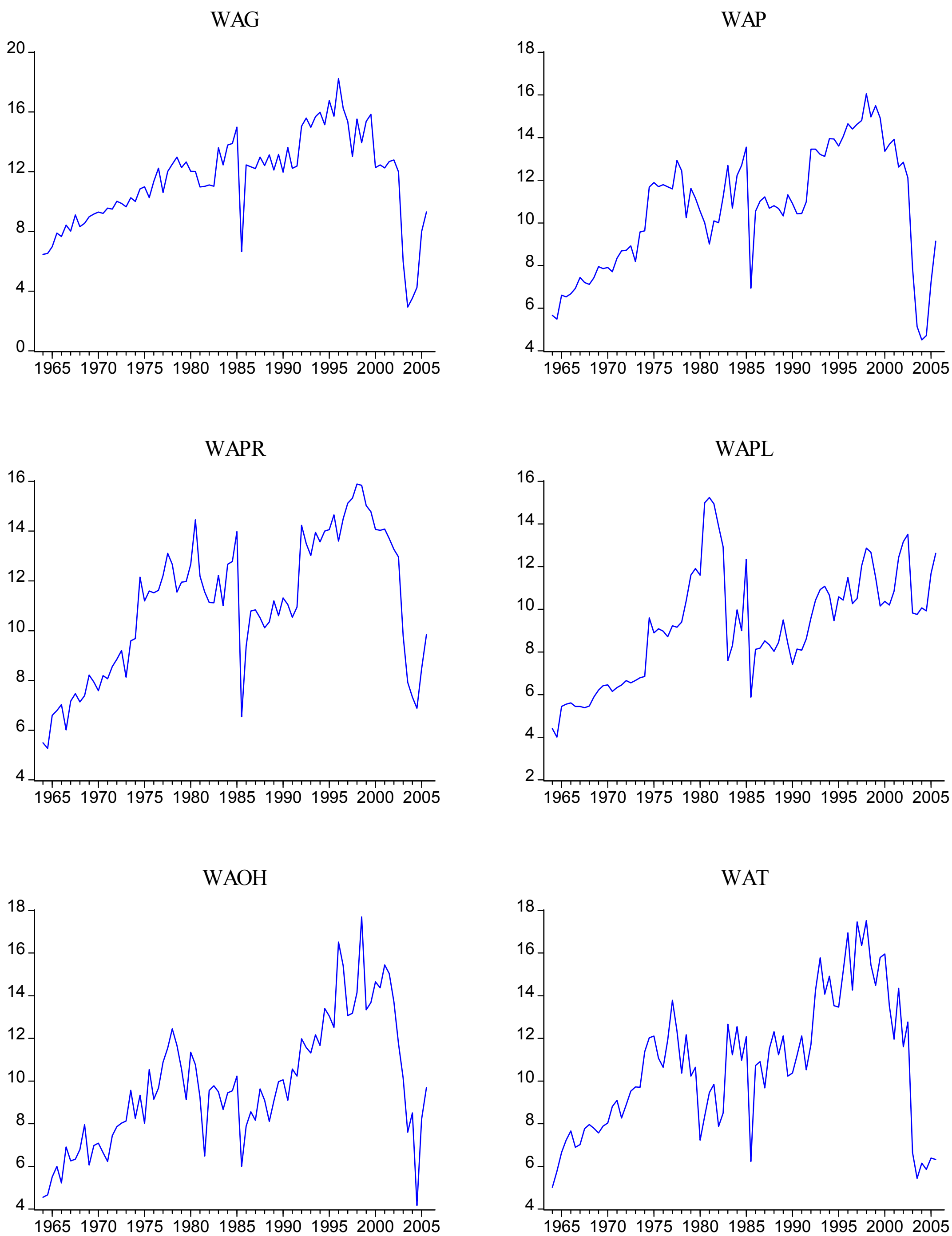




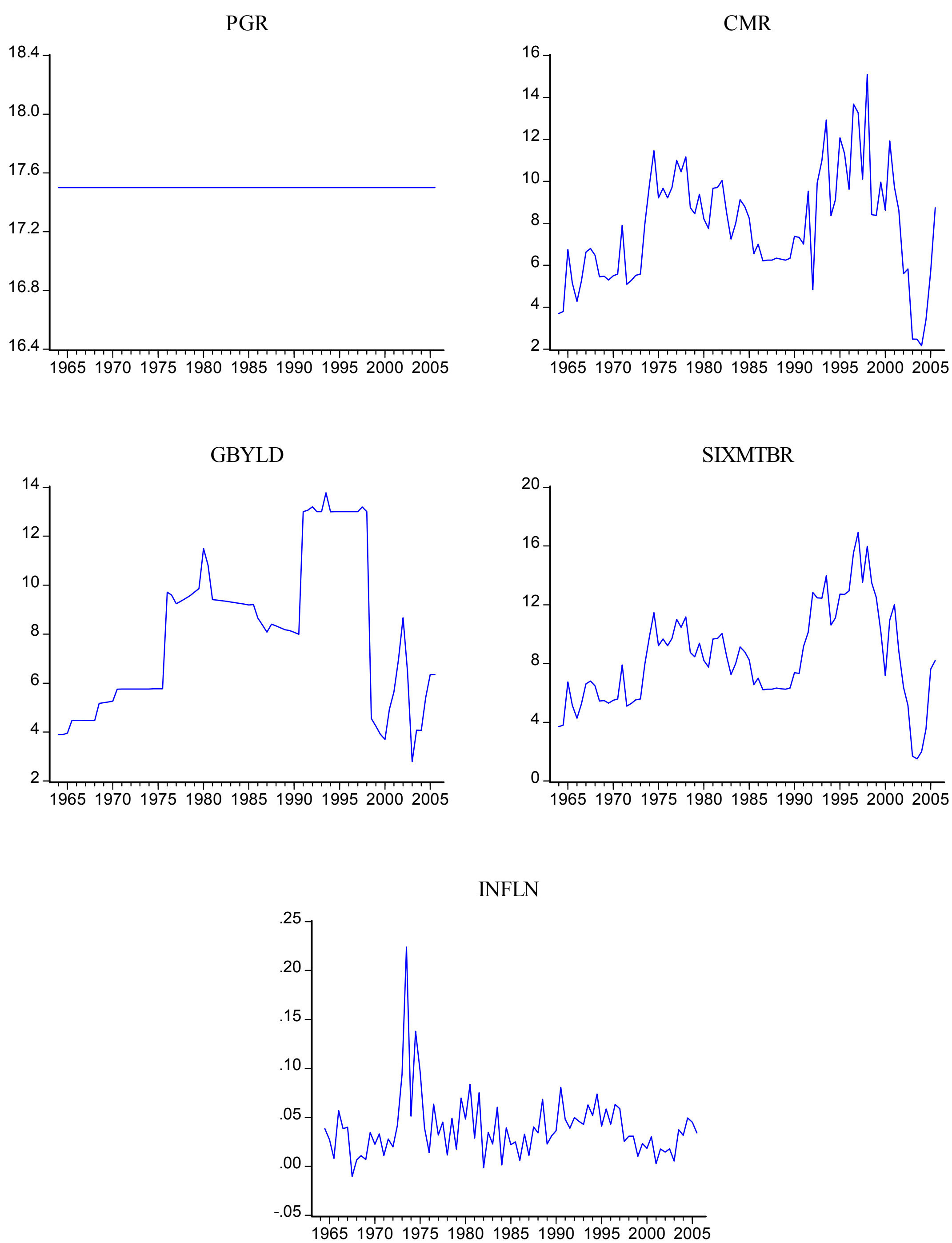
Figures 4.3.1(b): Exogenous variables (In Ratios : Rupees in Millions):



Figures 4.3.1(c): Interest rates (in Percent):



Interest rates (in Percent): Continued



4.4. Discussion of Empirical Results:

We have estimated various static and dynamic models. The type of estimated static models are, static model itself or static unrestricted model, static restricted model with symmetry, static restricted model with homogeneity and static restricted model with symmetry and homogeneity. Similarly, we have estimated dynamic unrestricted model, dynamic restricted model with dummy, dynamic restricted model without three interest rates (*wag, wap and warp*) and dynamic restricted model with dummy and without three interest rates (*wag, wap and warp*), dynamic unrestricted model with separate demand deposit and time deposit with dummy, dynamic restricted model with demand deposit equal to time deposit and with dummy. We have employed dummy for the structural break "between" 1985 to 1990 as discussed in chapter two. The analysis of model is given in table 4.4.1.

Table 4.4.1: Analysis of Models

Models	*Log-likelihood*	*Restrictions*	*LR-Test*	*Results*
Model 1	2401.39	*Unrestricted*		*Accepted*
Model 2	2371.09	*Restricted*	60.6> $\chi^2_{(36,0.05)}$= 50	*Rejected*
Model 3	2353	*Restricted*	47.45> $\chi^2_{(9,0.05)}$= 16.9	*Rejected*
Model 4	2365	*Restricted*	72.78> $\chi^2_{(45,0.05)}$= 67.5	*Rejected*
Model 5	2621.71	*Unrestricted*		
Model 6	2617.61	*Restricted*	8 < $\chi^2_{(9,0.05)}$= 16.98	*Accepted*
Model 7	2573.13	*Restricted*	63.6> $\chi^2_{(27,0.05)}$= 40	*Rejected*
Model 8	2586.14	*Restricted*	62.9> $\chi^2_{(27,0.05)}$= 40	*Rejected*
Model 9	2628.97	*Unrestricted*		*Accepted*
Model 10	2618.54	*Restricted*	20.8> $\chi^2_{(9,0.05)}$= 16.9	*Rejected*

Model 1: Static Unrestricted Model; **Model 2**: Static Restricted Model with Symmetry; **Model 3**: Static Restricted Model with Homogeneity; **Model 4**: Static Restricted Model with Symmetry & Homogeneity;**Model 5**: Dynamic Unrestricted Model; **Model 6**: Dynamic Restricted Model with dummy ;**Model 7**: Dynamic Restricted model with out three interest rates (*wag wap wapr*); **Model 8**: Dynamic Restricted Model with dummy and without three interest rates (*wag wap wapr*);**Model 9**: Dynamic Model with TTD and TDD separate with dummy ; **Model 10**: Dynamic Restricted Model with TTD=TDD with dummy.

The above analysis shows that, the model 1 as in equation (4.30) and model 9 as in equations (4.31) are the best models in the expected utility static and dynamic models, respectively. The dynamic model 9 is the extension of model 6.

The best static model has poor quality as R^2 and D-W statistics show in table 4.4.2 that the explanatory variables do not explain most of the dependent variables and they have also suffer from autocorrelation.

Table 4.4.2: Statistics for Static Unrestricted Model

EQNS	*R^2*	*D-W*
GOVTS	0.44	1.46
PUBS	0.44	1.19
PRIVS	0.46	0.94
PERS	0.29	0.92
OTHERS	0.55	1.24
TRUST	0.89	1.78
SUMB	0.46	1.29
FGS	0.25	0.53
TBILLS	0.76	1.06

As noted in table 4.4.1 the dynamic 9 is the best of the models, and it is that model whose results we present and analyze in what follow. The model 9 is consist of 10 choice items, 14 non choice items (ten interest rates of choice items and 4 exogenous variables), 10 lagged endogenous (dynamic effect) items and dummy. It is also superior to the best static unrestricted model 1, as it has high R^2, no AR in the residuals, no ARCH in the residuals, and the covariance matrix of the residuals indicates that the residuals do not suffer from covariance. Thus we can say that the residuals are independently distributed (that is, i.i.d).

Though they are dubious for models with lagged dependent variables, the DW stats from the FIML estimates in TSP suggest that there is no AR. LM test as one possible test for looking the AR shows that the different lags are statistically zero. Further, it does confirm that Fgs and Trust exhibit no AR up to lag 4 (give the LM tests and Chi-square probability), but other 7 residuals' series there is evidence of some AR up to lag 4, especially for Govt, Pubs, Pers and Sumb. Table 4.4.3 shows the correlogram test with lag length 7 confirms almost all equations are free of AR and ARCH in our dynamic unrestricted model 9.

Table 4.4.3: Correlogram Test at lag 7

GOVTS	*Q-Stat*	0.248	0.543	4.174	5.284	5.290	5.292	6.580
	Prob	[0.618]	[0.762]	[0.243]	[0.259]	[0.382]	[0.507]	[0.474]
PUBS	*Q-Stat*	2.019	2.816	2.831	2.871	4.648	4.952	8.586
	Prob	[0.155]	[0.245]	[0.418]	[0.580]	[0.460]	[0.550]	[0.284]
PRIVS	*Q-Stat*	1.070	1.725	2.140	2.331	2.524	2.524	2.526
	Prob	[0.301]	[0.422]	[0.544]	[0.675]	[0.773]	[0.866]	[0.925]
PERS	*Q-Stat*	12.174	18.509	24.457	27.208	27.232	29.664	30.097
	Prob	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
OTHERS	*Q-Stat*	0.086	0.145	0.225	11.938	11.946	12.479	12.569
	Prob	[0.769]	[0.930]	[0.974]	[0.018]	[0.036]	[0.052]	[0.083]
TRUST	*Q-Stat*	0.245	1.159	1.414	1.429	1.432	1.451	1.452
	Prob	[0.621]	[0.560]	[0.702]	[0.839]	[0.921]	[0.963	[0.984]
SUMB	*Q-Stat*	7.663	10.806	10.864	11.265	11.311	11.935	11.938
	Prob	[0.006]	[0.005]	[0.012]	[0.024]	[0.046]	[0.063]	[0.103]
FGS	*Q-Stat*	1.208	1.704	1.750	1.753	1.861	2.001	2.364
	Prob	[0.272]	[0.426]	[0.626]	[0.781]	[0.868]	[0.920]	[0.937]
TBILLS	*Q-Stat*	1.279	1.420	1.470	1.721	1.734	2.499	2.533
	Prob	[0.258]	[0.492]	[0.689]	[0.787]	[0.885]	[0.869]	[0.925]

Further, we have to see whether or not each of the 9 series of residuals is normally distributed. The J-Bera test suggests that Fgs, Pers, Pubs, Sumb and Tbills are: the other 4 are not. Those 4 suffer from outliers (extreme kurtosis); without which they would be normally distributed. We say all of this because strictly the use of FIML assumes that all residuals are normally distributed and are also independently distributed.

Finally, our best dynamic unrestricted model 9 is also stable. As discussed earlier, the characteristics roots of Z should lie between zero and unity. The dynamic system equation (4.23) would be stable if dominant root of the characteristic equation lies inside the complex unit circle. It can be seen from Table 4.4.4 that all eigenvalues are less than 1 in absolute value.

Table 4.4.4: Eigenvalues of the System's Dynamic Matrix

0.8620 + 0.1110i
0.6069 - 0.3476i
0.3443 + 0.0753i
0.6069 + 0.3476i
0.8620 - 0.1110i
0.7561
0.01
-0.348
0.2043
0.3443 - 0.0753i

Where as i is the imaginary number. So the multiplier effects will have a cyclical path for most of the variables.

4.4.1: Return on the Interest rate Matrix:

We employed ten rates of return in our dynamic model analysis. To repeat this for easy reference these are: WAG, weighted average rate of return on loans provided by scheduled banks to the Govt. sector; WAP, weighted average rate of return on loans provided by scheduled banks to the Public sector; WAPR, weighted average rate of return on loans provided by scheduled banks to the Private sector; WAPL, weighted average rate of return on loans provided by scheduled banks to the Personal Sector; WAOH, weighted average rate of return on loans provided by scheduled banks to the Other sector; WAT, weighted average rate of return on loans provided by scheduled banks to the Trust fund and non-profit organisation ; CMR, bank rate charged by the state bank of Pakistan; GBYLD, expected rate of return on Federal Govt. Securities; SIXMTB, expected rate of return on treasury bills; INFL, is the inflation rate which is used as rate of return on cash holding. The estimated co-efficient on these rates are shown in table 4.4.5.

Given the aggregation condition implied from the balance sheet constraint, we have dropped the cash equation from the system of demand equations. To obtain the interest rates responses of cash, we have used the Cournot aggregation condition.

Table 4.4.5: Estimated Impact Response: Rate of Return Variables.

EQNS	*WAG*	*WAP*	*WAPR*	*WAPL*	*WAOH*	*WAT*	*CMR*	*GBYLD*	*SIXMTBR*	*INFLN*
GOVTS	0.0006	-0.0004	-0.0006	0.0012	0.002	0.0011	0.0007	0.0003	-0.0023	0.0779
	[0.252]	[-0.112]	[-0.145]	[0.697]	[1.01]	[0.599]	[0.345]	[0.171]	[-1.11]	[1.01]
PUBS	0.002	0.0003	-0.0011	-0.0025	-0.0013	0.0006	0.001	-0.0016	-0.0017	-0.0656
	[1.05]	[0.0852]	[-0.34]	[-1.7]***	[-0.82]	[0.382]	[0.617]	[-0.982]	[-0.972]	[-1.04]
PRIVS	-0.0005	-0.0036	0.0015	0.0045	-0.0021	-0.0009	0.0036	-0.0001	0.0019	0.0179
	[-0.15]	[-0.621]	[0.258]	[1.78]***	[-0.74]	[-0.334]	[1.22]	[-0.04]	[0.615]	[0.161]
PERS	-0.0022	-0.0018	0.0017	-0.0002	-0.0011	0.0016	0.0006	-0.0016	0.0008	-0.072
	[-1.51]	[-0.726]	[0.688]	[-0.150]	[-0.924]	[1.35]	[0.496]	[-1.33]	[0.622]	[-1.49]
OTHERS	0.0001	-0.0004	0.0005	-0.0009	-0.0002	0.0004	0	0.0003	-0.0004	-0.0091
	[0.242]	[-0.764]	[1.07]	[-4.19]*	[-0.915]	[1.60]	[-0.016]	[1.12]	[-1.52]	[-0.932]
TRUST	-0.0003	0.00032	-2E-05	0.00003	-4E-05	-1E-05	7E-05	0.00005	-0.00002	-0.0009
	[-4.6]*	[2.53]**	[-0.173]	[0.594]	[-0.616]	[-0.113]	[1.04]	[0.817]	[-0.248]	[-0.362]
SUMB	-0.0024	-0.00258	0.0028	0.00382	0.00219	0.00208	0.006	0.00133	-0.00483	-0.0032
	[-1.11]	[-0.690]	[0.751]	[2.34]**	[1.20]	[1.19]	[3.15]*	[0.715]	[-2.46]**	[-0.04]
FGS	0.0005	-0.0067	0.0009	0.0005	0.0012	0.004	-0.0005	0.0034	-0.0002	-0.0727
	[0.233]	[-2.00]**	[0.274]	[0.351]	[0.711]	[2.54]**	[-0.311]	[2.04]**	[-0.114]	[-1.12]
TBILLS	-0.0029	0.0106	-0.0028	0.0015	0.0006	-0.0027	-0.0044	0.0023	-0.0006	0.0558
	[-0.876]	[1.93]***	[-0.508]	[0.606]	[0.228]	[-1.05]	[-1.57]	[0.853]	[-0.194]	[0.524]
CASH	0.0053	0.0043	-0.0029	-0.0079	-0.0012	-0.0061	-0.007	-0.0044	0.0073	0.0719
	[NA]	[NA]	[NA]	[NA]	[NA]	[NA]	[NA]	[NA]	[NA]	[NA]

*: Significant at 1% level. **: Significant at 5%level. ***: Significant at 10% level. NA: not available because is not estimated directly.

The elasticities for the rate of returns are given in table 4.4.6

Table 4.4.6: Rate of Return Elasticities

EQNS	*WAG*	*WAP*	*WAPR*	*WAPL*	*WAOH*	*WAT*	*CMR*	*GBYLD*	*SIXMTBR*	*INFLN*
GOVTS	0.15	-0.1	-0.14	0.24	0.42	0.26	0.12	0.06	-0.42	0.07
PUBS	0.43	0.05	-0.23	-0.42***	-0.24	0.12	0.15	-0.23	-0.26	-0.05
PRIVS	-0.01	-0.09	0.04	0.1***	-0.05	-0.02	0.07	0	0.04	0
PERS	-0.48	-0.36	0.35	-0.03	-0.21	0.32	0.09	-0.24	0.13	-0.05
OTHERS	0.37	-1.86	2.68	-3.88*	-0.99	1.89	0	1.03	-1.54	-0.16
TRUST	-2.4*	2.04**	-0.13	0.16	-0.23	-0.06	0.33	0.24	-0.1	-0.02
SUMB	-0.21	-0.2	0.22	0.25**	0.16	0.16	0.34*	0.08	-0.29**	0
FGS	0.05	-0.67**	0.09	0.04	0.11	0.4**	0.04	0.25**	-0.02	-0.03
TBILLS	-0.42	1.43***	-0.39	0.17	0.08	-0.37	-0.4	0.24	-0.06	0.03
CASH	0.56	0.43	-0.3	-0.68	-0.1	-0.61	-0.5	-0.32	0.57	0.03

The star (*, **, ***) values of elasticities is based on table 4.4.5

4.4.2: Results on the own-rate effects:

Five out of ten own-rates bear the correct sign; these are for Federal Govt. Securities, lending to Govt., Public and Private sectors and Cash holding. Among the own rate coefficient, the one corresponding to Federal Govt. Securities is only significant one. The best equation (in terms of the statistical reliability and signs of the coefficients) in table 4.4.5 is that of Sumb and FGS. It is also noticed that most of the elasticities are very small in table 4.4.6. Among own rates elasticities, ten out of ten own elasticities bear the correct sign. The most sensitive assets to the changes in the interest rates are Others and Trust sectors.

It is also noticeable that almost all of the own interest rates are very small which indicates the unresponsiveness of the choice assets to the changes in their own interest rates. So we can draw a conclusion that unless the monetary authority changes the interest rate sharply, there will be no major changes in the holdings of the assets as a result of the interest rate movements.

Therefore, these outcomes clearly run counter to a priori expectations about the direction of own-rates effects for some of the assets, and most co-efficients are insignificant on the basis of asymptotic t-ratios. As noted by Mclaren and Upcher(1986), this is common feature of such an unrestricted model[14].

4.4.3: Results on the Cross-rate effects:

With regard to off-diagonal rate of return's coefficients, the results show that only ten out of ninety coefficients in the yields' matrix are significantly different from zero: banks in Pakistan are not generally responsive to the movements in the yields on their assets.

[14] See Kagigi & Ford (1994,2001)

4.4.4: Results on non-choice Assets:

The results on the non-choice assets in table 4.4.7 show that fifteen coefficients out of forty-five directly estimated co-efficient are significantly different from zero. The exogenous balance sheet items appear to be the most likely candidates in explaining the portfolio behavior of schedule banks in Pakistan.

Table 4.4.7: Estimated Impact Response: Exogenous Balance Sheet Items.

EQNS	*PGS*	*CAPRES*	*TTD*	*TDD*	*DUMMY*
GOVTS	-0.46502	0.86203	-0.11314	0.00406	-0.04077
	[-0.872]	[2.20]**	[-1.50]	[0.051]	[-2.25]**
PUBS	-0.67136	-0.12098	0.10286	-0.0033	0.00289
	[-1.54]	[-0.378]	[1.67]***	[-0.05]	[0.194]
PRIVS	2.7308	-0.3811	-0.0991	0.06087	0.04942
	[3.55]*	[-0.675]	[-0.910]	[0.530]	[1.89]***
PERS	-0.43285	-0.45066	0.05574	-0.0039	0.00701
	[-1.30]	[-1.8]***	[1.18]	[-0.078]	[0.618]
OTHERS	-0.20621	0.04766	0.00205	0.00074	-0.0056
	[-3.07]*	[0.968]	[0.216]	[0.0737]	[-2.45]**
TRUST	0.01846	0.03633	0.00259	-0.0038	-0.00136
	[1.08]	[2.90]*	[1.07]	[-1.51]	[-2.35]**
SUMB	1.89552	-0.52108	-0.46003	-0.3041	0.0102
	[3.78]*	[-1.42]	[-6.48]*	[-4.07]*	[0.598]
FGS	0.56753	0.03416	-0.06787	-0.0071	0.00203
	[1.27]	[0.104]	[-1.07]	[-0.106]	[0.133]
TBILLS	0.11256	-0.75789	0.24909	0.10558	0.04288
	[0.153]	[-1.41]	[2.39]**	[0.963]	[1.71]***
CASH	-3.54943	1.25153	0.3278	0.15096	-0.0667
	[NA]	[NA]	[NA]	[NA]	[NA]

: Significant at 1% level. **: Significant at 5%level. ***: Significant at 10% level. NA: not available because is not estimated directly.

Table 4.4.8 Elasticities based on the Exogenous Assets

EQNS	*PGS*	*CAPRES*	*TTD*	*TDD*
GOVTS	-0.17	0.92**	-0.99	0.04
PUBS	-0.21	-0.11	0.77***	-0.02
PRIVS	0.11*	-0.04	-0.1	0.06
PERS	-0.14	-0.41***	0.42	-0.03
OTHERS	-1.6*	1.08	0.38	0.14
TRUST	0.19	1.07*	0.63	-0.93
SUMB	0.23*	-0.19	-1.35*	-0.89*
FGS	0.09	0.02	-0.26	-0.03
TBILLS	0.02	-0.47	1.28**	0.54
CASH	-0.56	0.57	1.24	0.57

The star (*, **, ***) values of elasticities is based on table 4.4.7

Above table 4.4.7 indicates the signs, magnitude and significance of the different explanatory variables. Table 4.4.8 shows the elasticities of the respective exogenous variables bear the correct sign. The major effects on the bank's portfolios of changes in assets and liabilities are summarized as follows,

- An increase in PGS (Provincial Govt. Securities) of 1 leads to a decrease in others sector of 0.20621, [elasticity,-1.6], and an increase in Banks borrowing of 1.89552, [elasticity, 0.23], and Private sector of 2.73080, [elasticity, 0.11].
- An increase in Capital and Reserve of 1 leads to a decrease in lending to the Personal sector 0.45066, [elasticity, -.41], and an increase in lending to the Trust & non Profit organization of 0.03633, [elasticity, 1.07], and Govt. sectors of 0.86203, [elasticity, 0.92].
- An increase in Total Time Deposit (liabilities) of 1 leads to a decrease in total borrowing of 0.46003, [elasticity,-1.35], and an increase in lending to the Public Sectors of 0.10286, [elasticity, 0.77], and Tbills of 0.24909, [elasticity, 1.28].

- An increase in Total Demand Deposit (liabilities) of 1 produces a decline in total borrowing of 0.30412, [elasticity, -0.89].

It should be noted that none of the exogenous variables in the Federal Govt. Securities equation came out as significant. However, in the SUMB equation most of the exogenous variables are significantly different from zero at 1% and 10%. It is noticed that the highest elasticities are those associated with deposits.

4.4.5: Results on the System's Dynamic Matrix:

Table 4.4.9 shows the system's dynamic matrix (*Z*) (derived from the estimated system by using Cournot aggregation condition to obtain information on the cash equation)[15]. It explains the internal dynamics of the endogenous assets structure by specifying how current state of the assets holdings portfolio depends on its lagged state in the absence of external pressure. In particular, the p^{th} row of Z gives indication how the current stock of the p^{th} asset is influenced by changes in the structure of assets last period and the p^{th} column of Z provides the rearrangement of the current assets structure induced by a partial change in the p^{th} asset. The diagonal elements of Z may be loosely, if somewhat incorrectly, interpreted as own adjustment rates; the smaller in absolute value the p^{th} diagonal element, the less inertia is exhibited in the adjustment of the p^{th} asset.

[15] See Ford (1994 2001)

Table 4.4.9: Estimated System's Dynamic Matrix (Z).

EQNS	*GOVTS_1*	*PUBS_1*	*PRIVS_1*	*PERS_1*	*OTHERS_1*	*TRUST_1*	*SUMB_1*	*FGS_1*	*TBILLS_1*	*CASH_1*	*R^2*	*D-W*
GOVTS	0.43769	0.0927	0.1202	-0.092	0.129	-3.8683	-0.20545	0.12922	0.01777	-0.0586	0.60	2.1
	[2.66]*	[0.541]	[1.12]	[-0.40]	[0.110]	[-1.22]	[-1.7]**	[1.29]	[0.186]	[-0.295]		
PUBS	0.42902	0.579	0.03589	0.29151	-0.20468	-0.0421	0.06225	-0.0221	-0.0067	-0.1991	0.76	2.5
	[3.18]*	[4.13]*	[0.408]	[1.58]	[-0.213]	[-0.016]	[0.622]	[-0.269]	[-0.086]	[-1.23]		
PRIVS	0.16214	0.43396	0.6404	0.24913	0.46604	4.65582	0.02379	0.09782	0.21139	0.07002	0.73	2.29
	[0.682]	[1.75]***	[4.13]*	[0.764]	[0.275]	[1.02]	[0.135]	[0.675]	[1.53]	[0.245]		
PERS	-0.07762	-0.12633	0.15033	0.33258	1.4119	-1.5883	-0.04218	0.01845	-0.0062	0.17247	0.60	2.36
	[-0.753]	[-1.18]	[2.23]**	[2.35]**	[1.92]***	[-0.800]	[-0.551]	[0.293]	[-0.104]	[1.39]		
OTHER	0.06999	0.01459	0.02056	0.03732	0.42382	0.40174	-0.03335	0.02135	-0.0023	-0.0319	0.80	1.71
	[3.37]*	[0.676]	[1.52]	[1.31]	[2.87]*	[1.01]	[-2.17]**	[1.7]***	[-0.191]	[-1.28]		
TRUST	0.00674	0.00381	-0.00658	0.00164	-0.07194	0.7146	-0.00015	-0.0019	0.00835	0.01568	0.95	2.15
	[1.28]	[0.695]	[-1.9]***	[0.226]	[-1.92]***	[7.04]*	[-0.0394]	[-0.61]	[2.73]*	[2.47]*		
SUMB	0.61569	0.727	0.51596	-0.0405	-0.77691	3.33264	-0.02991	0.47091	0.23133	0.12756	0.84	2.34
	[3.97]*	[4.51]*	[5.10]*	[-0.19]	[-0.705]	[1.12]	[-0.260]	[4.98]*	[2.58]**	[0.684]		
FGS	0.07536	-0.12638	0.03273	-0.2945	0.21163	3.28904	0.17288	0.81973	0.0674	-0.1401	0.83	2.37
	[0.545]	[-0.880]	[0.363]	[-1.55]	[0.215]	[1.24]	[1.69]***	[9.73]*	[0.842]	[0.843]		
TBILLS	-0.02614	-0.02773	-0.24237	0.29938	-0.94137	1.03347	-0.05756	-0.2631	0.45277	0.17574	0.88	2.28
	[-0.115]	[-0.117]	[-1.63]	[0.961]	[-0.582]	[0.236]	[-0.341]	[-1.9]**	[3.44]*	[0.643]		
CASH	-1.69288	-1.57063	-1.26713	-0.7846	-0.64748	-7.9286	0.10968	-1.2703	-0.9738	-0.1318	NA	NA
	[NA]	[NA]	[NA]	[NA]	[NA]	[NA]	[NA]	[NA]	[NA]	[NA]		

*: Significant at 1% level. **: Significant at 5%level. ***: Significant at 10% level. NA: not available because is not estimated directly.

The elasticities for the system dynamic matrix Z is given in table 4.4.10

Table 4.4.10: Elasticities for the System Dynamic Matrix (Z)

EQNS	*GOVS_1*	*PUBS_1*	*PRIVS_1*	*PERS_1*	*OTHERS_1*	*TRUST_1*	*SUMB_1*	*FGS_1*	*TBILLS_1*	*CASH_1*
GOVTS	0.335*	-0.242	2.181	-0.35	0.212	-0.208	-0.466**	0.237	-0.024	-0.602
PUBS	0.197*	0.922*	-0.356	0.354	-0.054	0.047	0.1	0.057	-0.103	-0.167
PRIVS	0.001	0.06***	0.831*	-0.005	0.008	-0.001	-0.069	0.054	0.025	0.069
PERS	-0.066	-0.098	0.532**	0.372**	0.063***	-0.002	-0.078	0.036	-0.008	0.234
OTHERS	0.402*	0.364	0.628	0.379	0.557*	0.114	-1.431**	0.759***	0.022	-0.82
TRUST	0.186	0.062	-0.30***	0.213	0.013***	0.891*	-0.219	-0.036	-0.002*	0.201*
SUMB	-0.001*	0.1*	0.367*	-0.205	0.002	-0.001	0.408	0.163*	0.066**	0.016
FGS	-0.003	-0.064	-0.047	-0.171	-0.009	0.02	0.203***	0.897*	0.044	0.106
TBILLS	0.255	-0.168	1.446	0.589	0.044	-0.263	-0.533	-0.83**	0.394*	0.473
CASH	-0.057	0.027	0.745	-0.05	0.023	-0.03	-0.068	0.198	0.019	0.227

The star (*, **, ***) values of elasticities is based on table 4.4.9

From the above table, we find that out of hundred coefficients of the lagged endogenous variables twenty-seven are significantly different from zero. It is also noticeable that all assets except SUMB do respond to their own disequilibrium. It is also noted from the elasticity table that the greatest own disequilibrium response is in Pubs sector loans which also react most to disequilibrium in CASH holdings. Further, some observations can be made on the structure of the system's dynamic matrix,

- The largest (in absolute value) off-diagnal elements of the dynamic matrix are found in the column relating to SUMB and CASH. The rows relating to lagged quantities of these two instruments are much smaller in absolute value. This suggest that changes in the lagged assets structure strongly affect SUMB and CASH holdings, but changes in these instruments have only small impact on other portfolio assets. Similarly, changes in the assets structure generate strong pressure on SUMB and cash holding, but these asset transfer very little of this pressure back into the rest of the portfolio, which is consistent with the view that SUMB and CASH holding as buffering function in asset structure.
- The magnitudes in the rows relating to lagged quantities of loans to OTHERS sector and TRUST sector substantially exceed magnitudes in the columns associated with their current stocks. This suggests that changes in these items transmit substantial adjustment pressure to the remaining items in the portfolio but they, in turn, absorb very little pressure from other changes in the portfolio.

As discussed earlier in section 4.2, dynamic matrix *Z= I-L,* where as *L (L=I-Z*) is the speed of adjustment matrix which is the "true" adjustment costs .Table 4.4.11 shows the estimated value of matrix *L* for illustration.

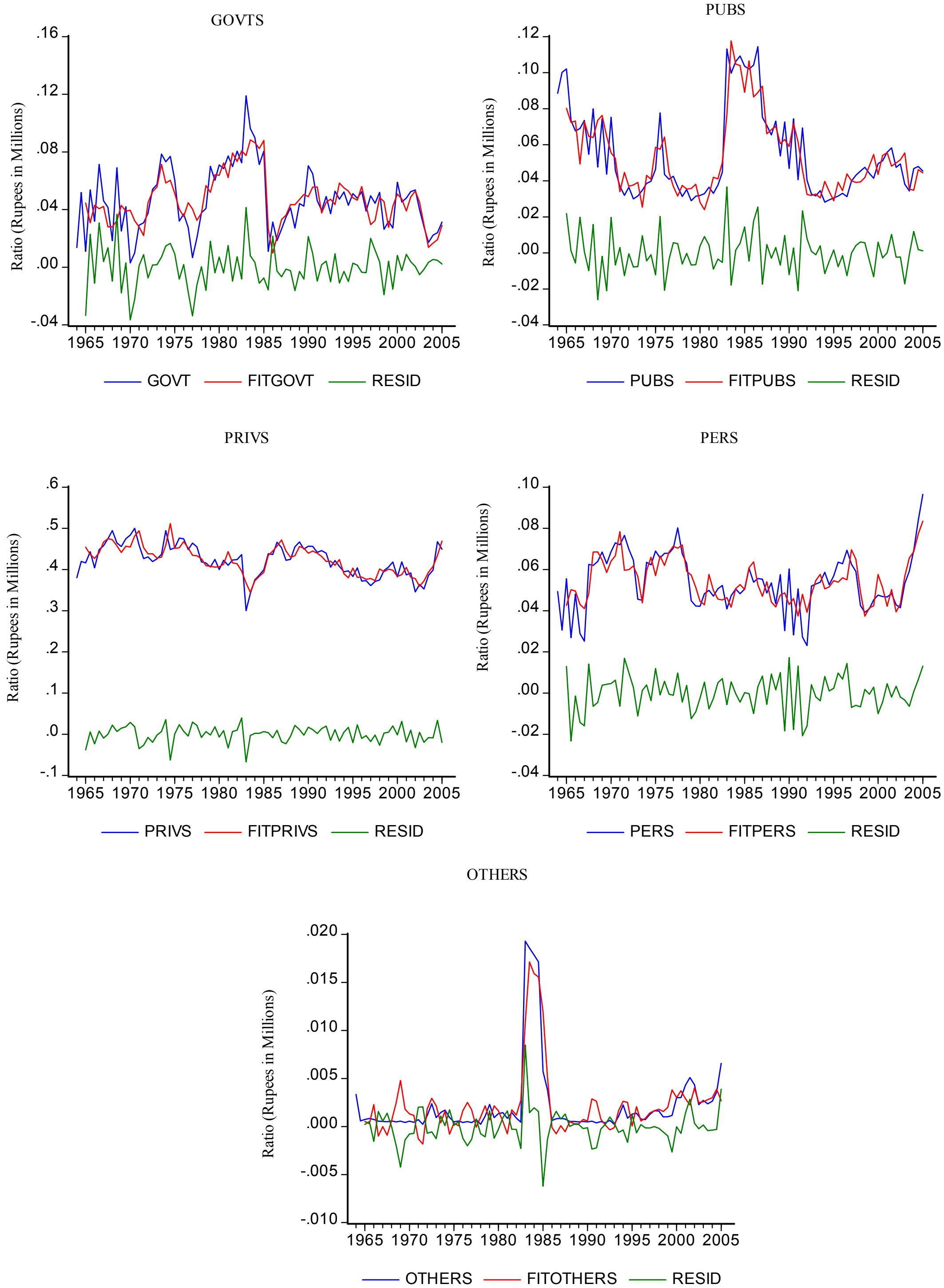
Table 4.4.11: *L* – Matrix for "True" Adjustment Costs

EQNS	*GOVTS_1*	*PUBS_1*	*PRIVS_1*	*PERS_1*	*OTHERS_1*	*TRUST_1*	*SUMB_1*	*FGS_1*	*TBILLS_1*	*CASH_1*
GOVTS	0.5623	-0.0927	-0.1202	0.0920	-0.1290	3.8683	0.2055	-0.1292	-0.0178	0.0586
PUBS	-0.4290	0.4210	-0.0359	-0.2915	0.2047	0.0421	-0.0623	0.0221	0.0067	0.1991
PRIVS	-0.1621	-0.4340	0.3596	-0.2491	-0.4660	-4.6558	-0.0238	-0.0978	-0.2114	-0.0700
PERS	0.0776	0.1263	-0.1503	0.6674	-1.4119	1.5883	0.0422	-0.0185	0.0062	-0.1725
OTHER	-0.0700	-0.0146	-0.0206	-0.0373	0.5762	-0.4017	0.0334	-0.0214	0.0023	0.0319
TRUST	-0.0067	-0.0038	0.0066	-0.0016	0.0719	0.2854	0.0002	0.0019	-0.0084	-0.0157
SUMB	-0.6157	-0.7270	-0.5160	0.0405	0.7769	-3.3326	1.0299	-0.4709	-0.2313	-0.1276
FGS	-0.0754	0.1264	-0.0327	0.2945	-0.2116	-3.2890	-0.1729	0.1803	-0.0674	0.1401
TBILLS	0.0261	0.0277	0.2424	-0.2994	0.9414	-1.0335	0.0576	0.2631	0.5472	-0.1757
CASH	1.6929	1.5706	1.2671	0.7846	0.6475	7.9286	-0.1097	1.2703	0.9738	1.1318

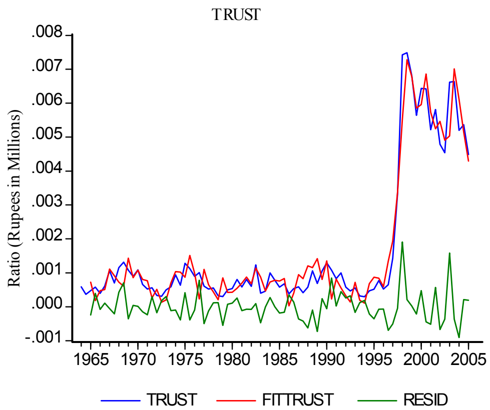
4.4.6: The Overall Evaluation of the dynamic Model: Explanatory and Predictive Performance:

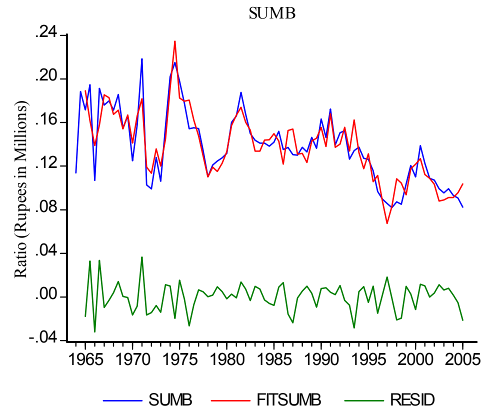
This section is relates to the estimated equations and their properties of residuals. We are going to present fitted and actual values for the equations, the stability of the coefficients over the estimation period using recursive graphics. The fitted values and actual values of the estimated equations for all endogenous variables for the whole sample period (1964:2-2005:1) indicate that most of the variables, have no divergence between actual and fitted values *(See Figures 4.3.2)*

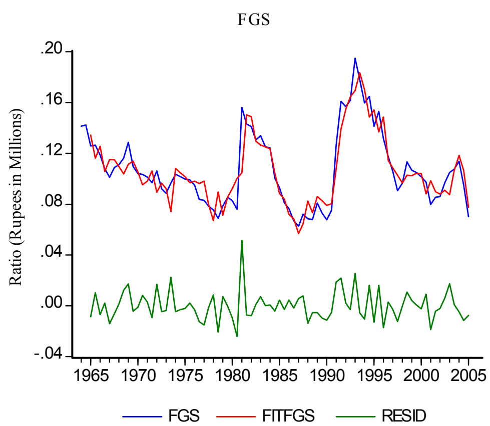
Figures 4.3.2: Actual and fitted Value (with Residual)

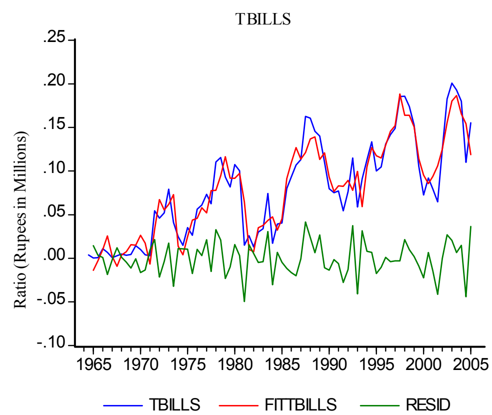


Actual and fitted Value (with Residual): Continued









According to the recursive graphic analysis as reflected by the one step ahead for residuals, we find that the results are good *(See Figures in Appendix A)*. Based on stability tests indicate that results for most of the variables are good except lending to the trust sector. However, we can argue that the results of this dynamic model still much better than the stability tests that produced by static model *(See Figures in Appendix A)*.

4.4.7: Impact Effects of Exogenous Variables on the Pakistani Banks' Portfolios:

In this section we see the impact of the exogenous variables on the portfolio of the Pakistani banks. First of all, we look at some of the effects caused by rates of return on; Federal Govt. Securities, Treasury Bills, Banks' borrowings, lending to the Govt. Pubs, Privs, Pers, Others and Trust sectors. Then, we analyse to discuss the impact (current) and interim effects of the exogenous variables on the portfolio of the commercial banks in Pakistan presented in the table (4.4.12).

Table 4.4.1 Proximate Impact Effects of Ceteris Paribus Unit Changes in Exogenous Variables on the Portfolio of Pakistani Banks

Exogenous Variables*	**Effects on the Choice Set (millions of rupees)**								
EQUNS	*GOVTS*	*PUBS*	*PRIVS*	*PERS*	*OTHERS*	*TRUST*	*SUMB*	*FGS*	*TBILLS*	*CASH*
WAG	0.0006	0.0020	-0.0005	-0.0022	0.0001	-0.0004	-0.0025	0.0005	-0.0029	0.0053
WAP	-0.0004	0.0003	-0.0036	-0.0018	-0.0004	0.0003	-0.0026	-0.0067	0.0106	0.0043
WAPR	-0.0006	-0.0011	0.0015	0.0017	0.0005	-0.00002	0.0028	0.0009	-0.0028	-0.0029
WAPL	0.0012	-0.0025	0.0045	-0.0002	-0.0009	0.00003	0.0038	0.0005	0.0015	-0.0079
WAOH	0.0020	-0.0013	-0.0021	-0.0011	-0.0002	-0.00004	0.0022	0.0012	0.0006	-0.0012
WAT	0.0011	0.0006	-0.0009	0.0016	0.0004	-0.00001	0.0021	0.0040	-0.0027	-0.0061
CMR	0.0007	0.0010	0.0036	0.0006	0.0000	0.00007	0.0060	-0.0005	-0.0044	-0.0070
GBYLD	0.0003	-0.0016	-0.0001	-0.0016	0.0003	0.00005	0.0013	0.0034	0.0023	-0.0044
SIXMTBR	-0.0023	-0.0017	0.0019	0.0008	-0.0004	-0.00002	-0.0048	-0.0002	-0.0006	0.0073
INFLN	0.0779	-0.0656	0.0179	-0.0720	-0.0091	-0.0009	-0.0032	-0.0727	0.0558	0.0719
PGS	-0.4650	-0.6714	2.7308	-0.4329	-0.2062	0.0185	1.8955	0.5675	0.1126	-3.5494
CAPRES	0.8620	-0.1210	-0.3811	-0.4507	0.0477	0.0363	-0.5211	0.0342	-0.7579	1.2515
TTD	-0.1131	0.1029	-0.0991	0.0557	0.0021	0.0026	-0.4600	-0.0679	0.2491	0.3278
TDD	0.0041	-0.0033	0.0609	-0.0039	0.0007	-0.0038	-0.3041	-0.0071	0.1056	0.1510
DUMMY	-0.0408	0.0029	0.0494	0.0070	-0.0056	-0.0014	0.0102	0.0020	0.0429	-0.0667

*Unit changes in the interest rate are 1%.

A ceteris paribus one percent change in the interest rate on Federal Govt. securities (GBYLD) seems to cause an increase in the bank borrowing by a small fraction (0.0013). Further, the same percent change would cause an increase in the holding of the Federal

Govt securities by very tiny percentage of 0.0034%. On the other hand, such an increase produces a rise in the holdings of treasury bills by 0.0023 percent and loans to the Govt sector by 0.0003 percent, the Others sector by 0.0003 percent, and the Trust sector by 0.00005 percent. However, such an increase leads to a decrease Pers sector loans 0.0016 percent and Pubs sector loans by 0.0016 percent.

A ceteris paribus one percent increase in the rate of return on Treasury Bills (SIXMTB) would produce an immediate unexpected decrease in the demand for Treasury bills and lending to the Pers and Privs sectors. However, such an increase would lead to a decline in lending to the Govts, Others, Pubs and Trust sectors. Further, this increase leads to decreased demand for Federal Govt. securities, banks' borrowings and, surprisingly, increase demand for Cash holding. So, we can conclude here that banks invest more in Treasury bills, Private and Personal sectors, as they are profitable opportunities.

A ceteris paribus one percent change in cost of borrowing (CMR) leads to a decrease in Cash holding and to an increase in demand for lending to Govts, Pubs, Privs, Pers, Others, and Trust sectors. We also observe that such an increase leads to a decrease in the demand for Federal Govt. securities and Treasury Bills .Further this increase will lead to an increase in the demand for funds by borrowings. This is understandable on the basis that the banks found it is profitable to borrow at specified rate and lend it on profitably to the different sectors. This is confirmed by the fact that an increase in this rate would produce almost an equal increase in loans to the different sectors. However, such actions are incapable of restraining the credit expansion by the authorities since any increase in the bank rate will generate similar direction and "quantity" of both borrowing from the central bank and lending to the different sectors.

A ceteris paribus one percent change in the rate of return on Govt sectors loans (WAG) leads to an immediate increase in demand for Federal Govt securities and to an increase in lending to Govts, Pubs, and Others sectors and Cash holding. However, such an increase leads to a decrease in demand for Treasury bills, banks' borrowing, lending to the Privs, Pers and Trust sectors.

A ceteris paribus one percent change in the rate of return on Public sector loans (WAP) leads to an increase in demand for Treasury bills and to an increase in lending to the Public and Trust sectors. It is also observed that this increase leads to a decrease in demand for Federal Govt. securities, borrowing and lending to the Govt, Privs, Pers and Others sectors. This increase leads to an increase in Cash holding.

A ceteris paribus one percent increase in the interest rate of return on Private sectors loans (WAPR) would produce immediate decrease in Cash holding and to an increase in demand for Federal Govt securities and lending to the Privs, Pers and Others sectors. This increase also decreases demand for Treasury bills and lending to the Govts, Public and Trust sectors. Further, this increase will lead to increase in the demand for borrowing for banks to make profitable investment in different sectors of the economy; in this case, these are Privs, Pers and Others sectors.

A ceteris paribus one percent increase in the rate of return of Personal sector (WAPL) leads to an immediate increase in the demand for Federal Govt. securities, Treasury Bills and lending to the Govt, Privs and Trust sectors. Unexpectedly, such an increase leads to produce an immediate decrease in Pers sector. Again, this increase leads to decrease Cash holding and an increase in demand for banks' borrowing (discussed above the relationship between borrowing and investment). On the other hand, such an increase leads to a decrease in lending to the Pubs, Pers and Others sectors.

A ceteris paribus one percent increase in the rate of return on the Other sector loans (WAOH) leads to an immediate increase in the demand of Federal Govt securities, Treasury bills and Govt sector. Unexpectedly, this increase leads to decrease in lending to Others sector. Surprisingly, such an increase will lead to an increase in demand for bank borrowing and a decrease in demand for Cash holding. As mentioned above, this is justifiable as banks found it is profitable to borrow from the specified rate and lend it profitably to the Govt. sector. This increase also leads to a decrease in lending to the Pubs, Privs, Pers,Other and Trust sectors.

A ceteris paribus one percent increase in the rate of return on Trust sectors loans (WAT) leads to an immediate decrease in Cash holding and to an increase in the demand for Federal Govt. securities and lending to the Govts, Pubs, Pers and Others sectors. Also this increase leads to decrease in the demand for the Treasury bills and lending to the Privs and Trust sectors. Further, such an increase leads to an increase in the demand for banks borrowing.

A ceteris paribus one percent increase in the inflation rate (INFL) leads to an immediate decrease in cash holdings, Treasury bills and lending to the Govt., and Privs sectors. The increase in inflation also leads an increase in Federal Govt. securities and lending to the Pubs, Pers, Others and Trust sectors. In addition, such an increase leads to a decrease in banks' borrowing.

Now, we turn to see the impacts arising from a change in deposits. A ceteris paribus one million/rupees change in the deposits (TTD) would lead to an increase 0.2491 million/rupees in the Tbills holdings by the commercial banks. Similarly, such increase in deposits would produce an increase in lending to the Pubs, Pers, Other, Trust sectors by 0.1029, 0.0557, 0.0021 and 0.0026 millions respectively. However, this increase in deposits will decrease the demand for Fgs by 0.0679 millions, borrowing by 0.4600 millions, lending to Govts sector by 0.1131 millions and lending to the Privs sector by 0.0991 millions. In this case, we see this increase leads to an increase the demand for cash holding and a decrease in banks borrowing.

A ceteris paribus one percent increase in TDD leads to an immediate decrease in, Pubs, Pers and Trust sector loans. This increase also leads to a decline in Fgs and bank borrowing. On the other hand this increase in TDD also increases the demand for Treasury Bills, lending to the Govt, Privs and Others sectors. Further, this increase leads to reduction in banks borrowing and increase in cash holdings.

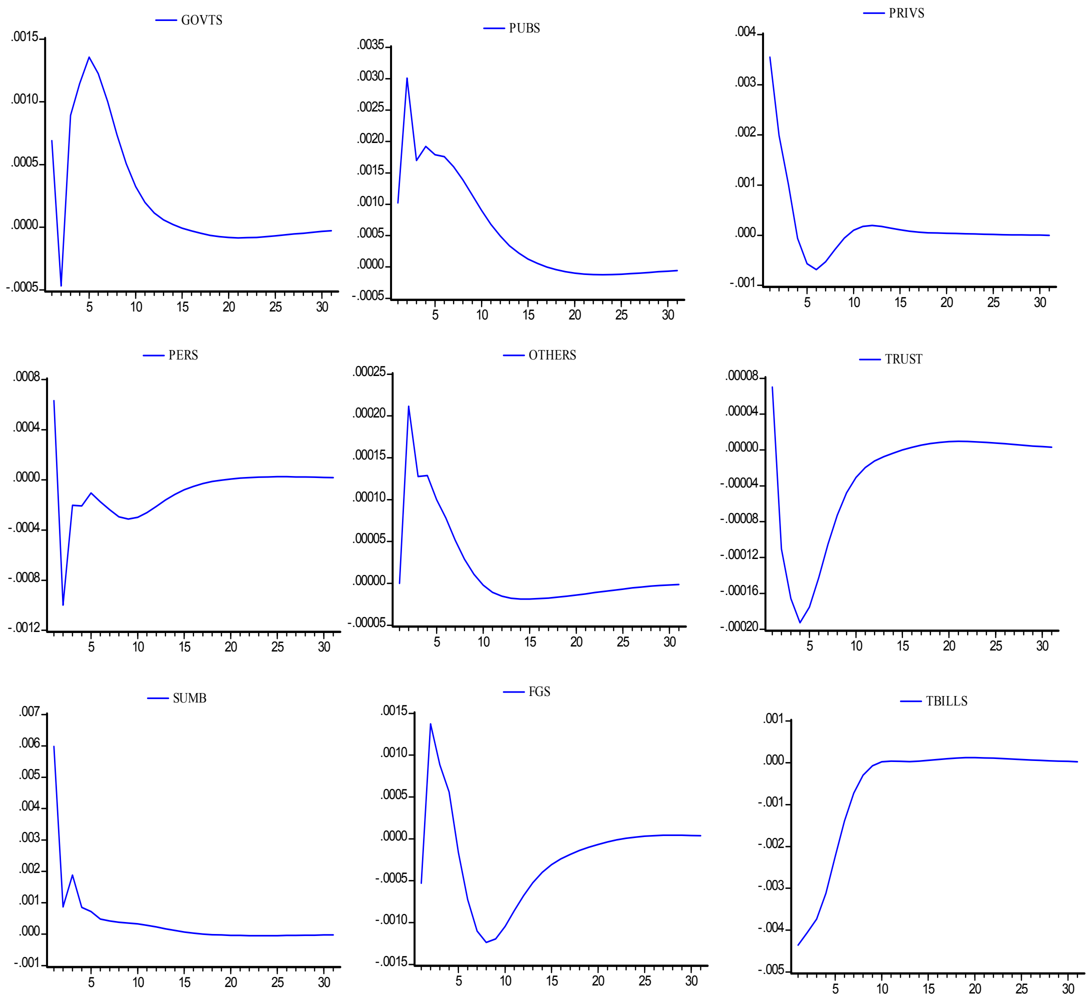
4.4.8: Interim Effects of Exogenous Variables s on the Pakistani Banks' Portfolio:

In this section, rather than considering the impact of all of the exogenous variables, we are selecting those that can be influenced by the central bank. These are: *Cmr, Gbyld, Sixmtbr, TTD and TDD*. It is studying these multiplier impacts we are looking at the ceteris paribus impacts that changes in monetary conditions, engineered by the State Bank of Pakistan, have on the behaviour of the banks.The interim multiplier effects for exogenous variables on the set of choice assets are shown in figure (4.4.7), where time is on horizontal axis (30 period). They all exhibit decreasing amplitude around zero over time since the model is stable.

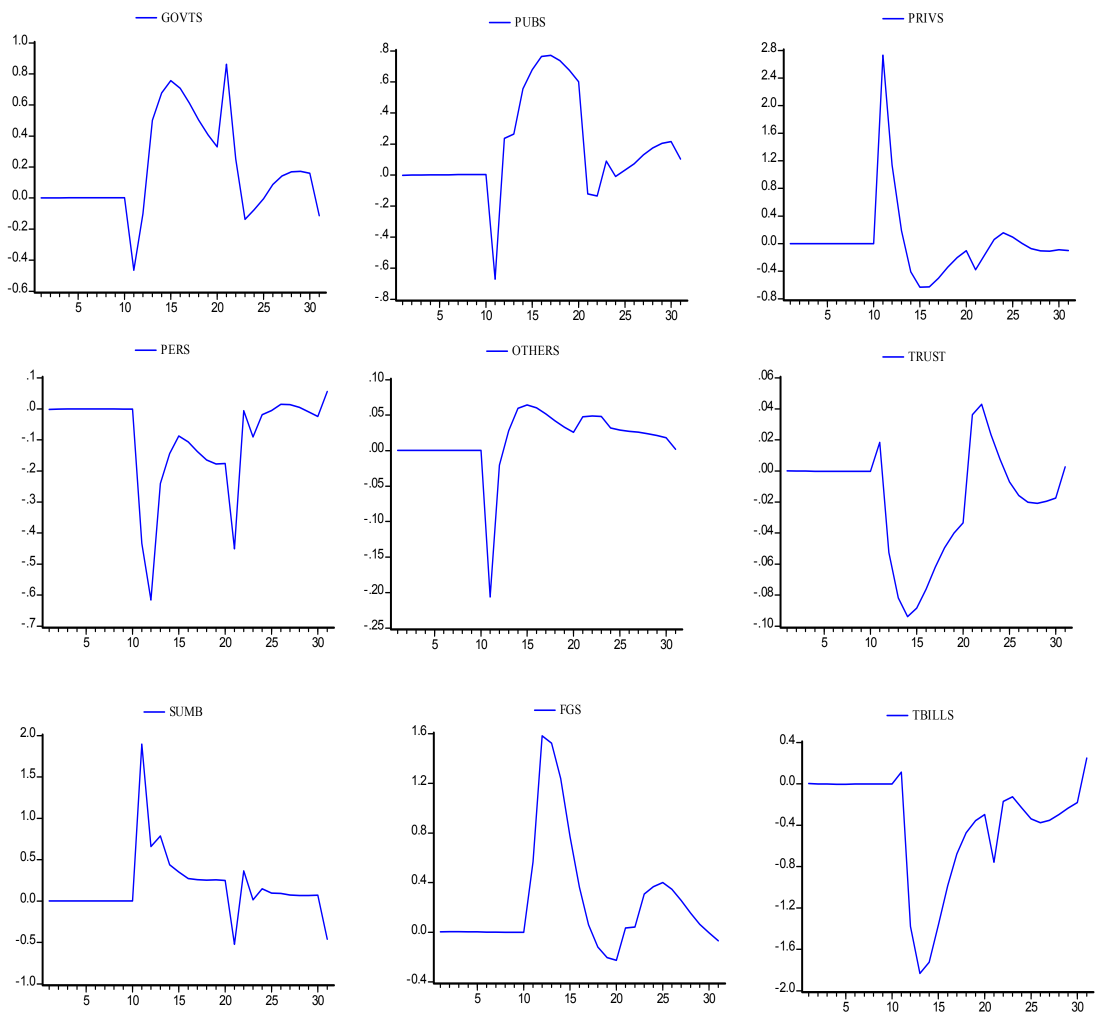
We can say that *Sixmtbr* is more effective in influencing the scheduled commercial banks in Pakistan for interim effects towards choice assets since they diffuse much longer than *Gbyld* and *Cmr* (after about 25 period for *Sixmtbr,* around 24 period for *Gbyld* and 15 period for *Cmr*) . It illustrates that all of the interim effects of *Gbyld* on choice assets still last towards the end of the observation. On the other hand, we notice that the interim effects of *TDD* is more effective in influencing commercial banks behaviour towards choice assets since *TDD* interim effects last longer (about 25 period) than *TTD* interim effects that diffuse just after 20 periods to become zero towards the end of the period. The reason behind this might be that the ratio of *TDD* that might be bigger than *TTD* to total deposits in commercial banks; this evidence might be caused by the Pakistani depositors preference to keep their money into demand deposits account.

Figure 4.4.7:

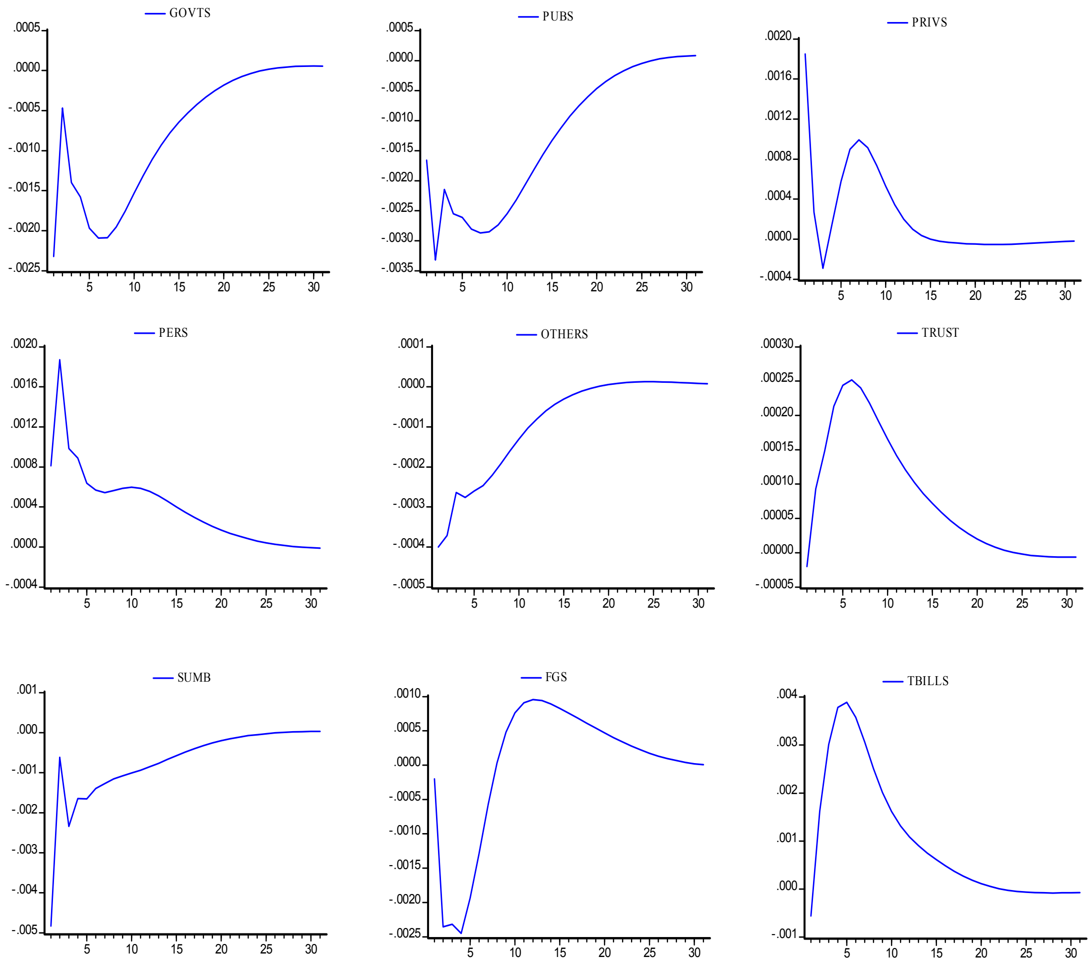
1. The effects of exogenous variables (CMR) on endogenous variables.



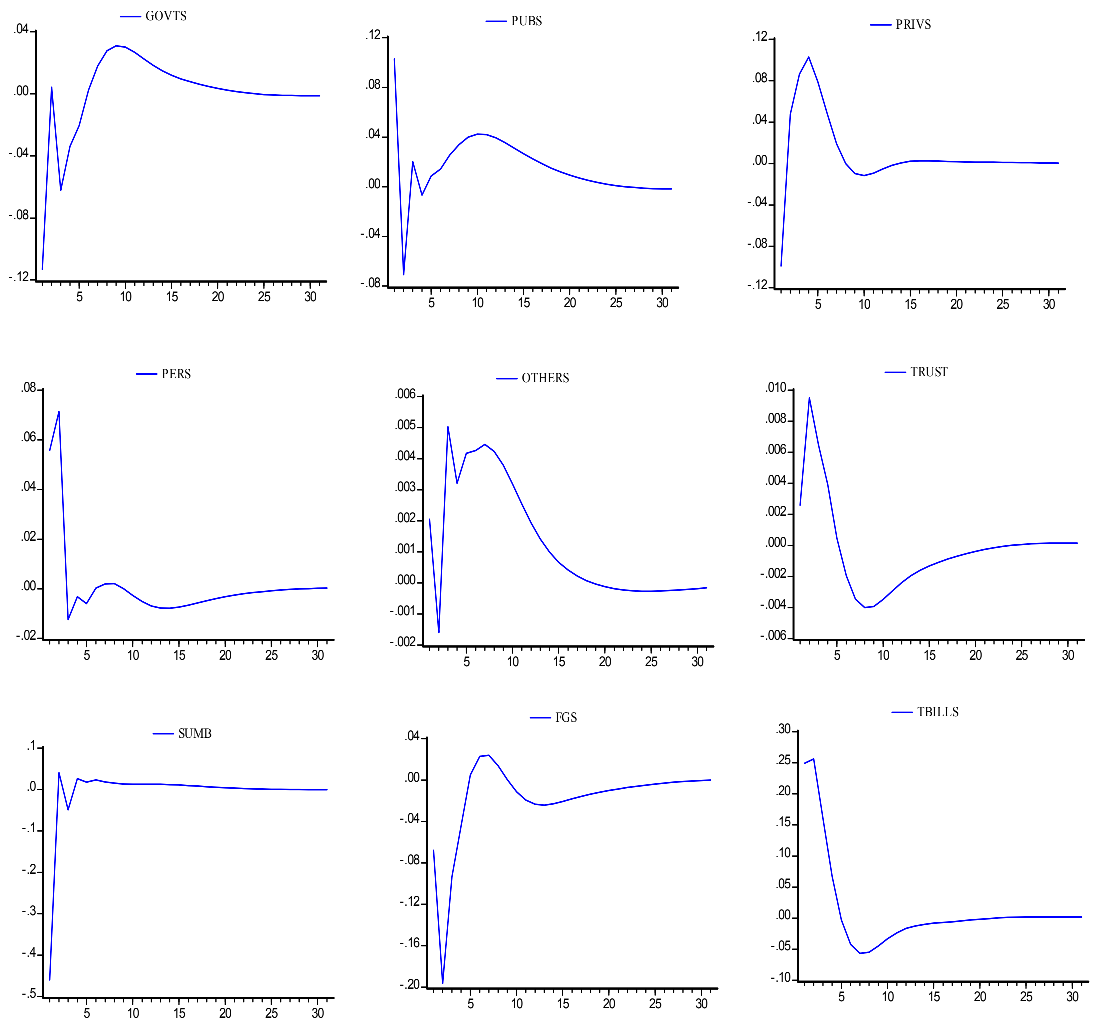
2. The effects of exogenous variables (GBYLD) on endogenous variables.



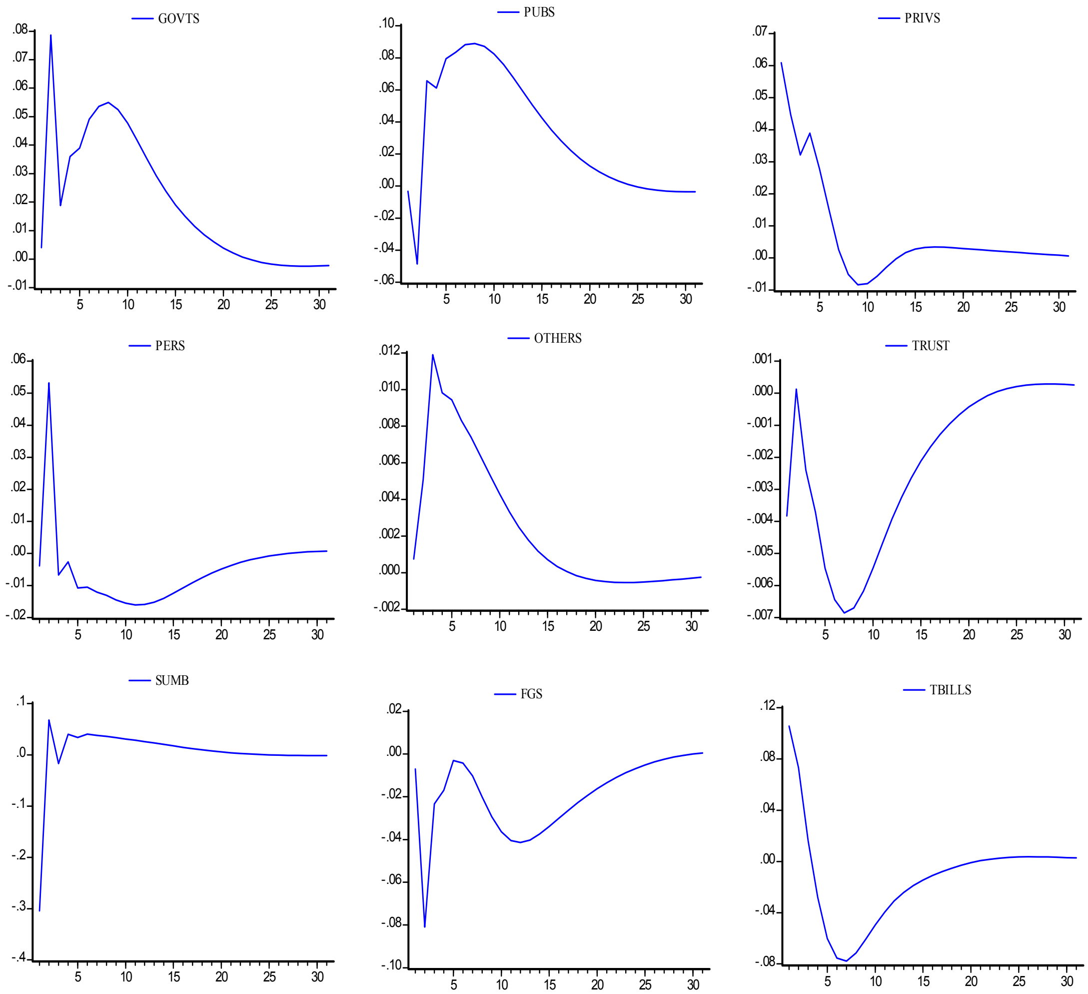
3. The effects of exogenous variables (SIXMTBR) on endogenous variables.



4. The effects of exogenous variables (TTD) on endogenous variables.



5. The effects of exogenous variables (TDD) on endogenous variables.



4.4.9: Total Effects of Exogenous Variables on the Pakistani banks' Portfolio:

The previous section considered impact and interim multiplier effects of selected exogenous variables, and now we present their cumulative impacts after they have all ceased, namely, their long-run effects. These are given in 4.4.13.

Table 4.4.13 Total Effects of Ceteris Paribus Unit Changes in Exogenous Variables on the Portfolio of Pakistani Banks

Exogenous Variables*	Effects on the Choice Set (millions of rupees)								
EQNS	*GOVTS*	*PUBS*	*PRIVS*	*PERS*	*OTHERS*	*TRUST*	*SUMB*	*FGS*	*TBILLS*
CMR	0.02182	0.02807	-0.0087	-0.0098	0.00287	-0.00235	0.016433	0.014702	-0.0289
GBYLD	-0.02323	-0.0390	0.00664	0.0121	-0.00272	0.002407	-0.0225	-0.00083	0.02976
SIXMTBR	-0.05082	-0.4104	-0.0304	-0.0631	-0.03068	0.022263	-0.10083	0.093597	0.26315
TTD	0.60159	0.97034	0.23003	-0.1519	0.07194	-0.06553	0.152843	-0.57859	-0.3411
TDD	-0.00104	0.05929	0.05597	-0.0223	-0.01071	-0.00822	0.042252	-0.01828	0.01099

*Unit changes in the interest rate are 1%.

Comparing Tables (4.4.12) and (4.4.13), there are alterations of sign between corresponding impact and total multipliers relating to several variables. The effect of the variable lending to Treasury Bills has the correct sign under the total multiplier effect.

A major reason for these outcomes could be the fact that the monetary authorities relied mainly on direct controls as a means of influencing the portfolio behaviour of the banks during most of the periods. Therefore, it is not unlikely that the response of the banks to these kinds of policies was negative, especially in respect of the interest rates.

No clear conclusion emerges as to the banks' preference between the different sources of funds. However, it seems that the banks are more responsive in applying funds to more liquid assets than they are to non-liquid portfolios. The results also confirm the importance of banks' capital (Pringle; 1974) in terms of banks' reaction towards choice asset.

4.5: The Aggregation of Loans: A Comparison Between The Best Disaggregated And Aggregated Model.

In the aggregated model, we have aggregated all loans and used the notation for aggregated loans in the table is "Loan" which is summation of Govt, Pubs, Pers, Privs, Others and Trust sectors loans and remaining items are as it is. The basic idea is to see if there is a loss of information in explaining the items in the portfolio, and hence the total portfolio, in aggregating all loans, implying that they are perfect substitutes for the banks. We have estimated various dynamic aggregated expected utility models. These are: aggregated dynamic unrestricted model, aggregated dynamic restricted model with homogeneity, aggregated dynamic restricted model with symmetry and dynamic restricted model with homogeneity and symmetry. The analysis of models is given in table 4.5.1.

4.5.1: Analysis of Aggregated EU Models

Models	*Log-likelihood*	*Restrictions*	*LR-Test*	*Results*
Model 1	864.342	*Unrestricted*		
Model 2	863.942	*Homogeneity*	$0.8 < \chi^2_{(4,0.05)} = 9.48$	*Accepted*
Model 3	862.125	*Symmetry*	$4.43 < \chi^2_{(6,0.05)} = 12.59$	*Accepted*
Model 4	861.755	*Homogeneity & Symmetry*	$5.17 < \chi^2_{(10,0.05)} = 18.30$	*Accepted*

Model 1: Dynamic Unrestricted Model; **Model 2**: Dynamic Restricted model with Homogeneity; **Model 2:** Dynamic Restricted Model with Symmetry; **Model 4**: Fully Restricted Dynamic Model with Symmetry and Homogeneity

We find aggregated expected utility dynamic model with symmetry & homogeneity restrictions wins in Table 4.5.1 and this dynamic model is stable as well. It can be seen from Table 4.5.2 that all eigenvalues are less than 1 in absolute value.

4.5.2: Eigenvalues of the System's Dynamic Matrix

0.723848 + 0.0489878i
0.723848 - 0.0489878i
0.573795
-0.358968
1.85E-16

We have already presented tables and explained disaggregated model in previous section, we also present results for the best aggregated model in table 4.5.3, which shows that the behaviour of the expected utility aggregated model with symmetry and homogeneity restrictions is similar to the disaggregated model. Here, the best equation in terms of significance is sumb equation.

Table 4.5.3: Aggregated Expected Utility Dynamic Model (with Symmetry & Homogeneity Restrictions)

EQNS	*WARRA*	*CMR*	*GBYLD*	*SIXMTBR*	*INFLN*	*PGS*	*TDD*	*TTD*	*CAPRES*	*DUMMY*
LOANS	-0.00688	0.00372	-0.00039	0.00070	0.00285	0.37029	0.06732	-0.01771	0.54623	-0.01801
	[-0.59]	[1.11]	[-0.13]	[0.09]		[0.22]	[0.29]	[-0.08]	[0.64]	[-0.42]
SUMB	-0.00372	-0.0032	0.00077	0.00237	0.00380	-0.7555	0.25647	0.41907	0.06726	0.01240
	[1.11]	[1.28]	[-0.34]	[-1.02]		[0.91]	[-1.83]	[-2.69]*	[-0.08]	[-0.33]
FGS	-0.00039	-0.0008	0.00164	0.00070	-0.00118	0.21907	0.04867	-0.03773	0.42579	-0.00871
	[-0.13]	[-0.34]	[0.49]	[0.24]		[0.23]	[0.34]	[-0.22]	[0.39]	[-0.19]
TBILLS	0.00070	-0.0024	0.00070	0.00008	0.00090	-0.59320	0.17799	0.34076	-0.80967	0.04245
	[0.09]	[-1.02]	[0.24]	[0.02]		[-0.68]	[0.73]	[1.47]	[-0.66]	[0.90]
CASH	0.0103	0.00264	-0.00272	-0.00385	-0.00637	0.75939	-0.55044	-0.70439	-0.22961	-0.02813
	[NA]	[NA]	[NA]	[NA]	[NA]	[NA]	[NA]	[NA]	[NA]	[NA]

*: Significant at 1% level. **: Significant at 5%level. ***: Significant at 10% level. NA: not available because is not estimated directly.

Table 4.5.4: Dynamic Matrix (Z) for Aggregated Expected Utility Model with Symmetry & Homogeneity Restrictions

EQNS	*LOANS_1*	*SUMB_1*	*FGS_1*	*TBILLS_1*	*CASH_1*	*R^2*	*D-W*
LOANS	0.95828	-0.14104	0.18160	0.26591	0.02100	0.73	2.51
	[3.64]*	[-0.26]	[0.51]	[0.94]	[0.04]		
SUMB	-0.44409	-0.16322	-0.37638	-0.28048	-0.20227	0.72	1.91
	[2.54]*	[0.75]	[2.18]**	[1.58]	[0.51]		
FGS	-0.09505	0.25155	0.80408	0.08123	0.01316	0.78	1.95
	[-0.38]	[1.01]	[3.83]*	[0.42]	[0.02]		
TBILLS	-0.13934	-0.12406	-0.31288	0.36347	0.07009	0.86	2.02
	[-0.58]	[-0.34]	[-1.25]	[1.64]	[0.11]		
CASH	-0.2798	0.17677	-0.29643	-0.43013	0.09802	[NA]	[NA]
	[NA]	[NA]	[NA]	[NA]	[NA]		

*: Significant at 1% level. **: Significant at 5%level. ***: Significant at 10% level. NA: not available because is not estimated directly.

To see the comparison between expected utility disaggregated and aggregated models, we plot different forecasting and other statistics below.

Table 4.5.5: EU Disaggregated forecasting table (1964:1 to 2005:1)

EQNS	*RMSE*	*MAE*	*MAPE*	*Theil I Coeff*	*Bias Prop*	*Var Prop*	*Cov Prop*	*R^2*
LOANS	0.022710	0.01818	3.046623	0.019108	0.000006	0.083217	0.916777	0.77
GOVT	0.0139	0.0104	48.5845	0.1376	0.0000	0.1194	0.8806	0.6
PUBS	0.1136	0.0085	16.6517	0.0984	0.0000	0.0664	0.9336	0.76
PRIVS	0.0200	0.0154	3.6826	0.0236	0.0000	0.0592	0.9408	0.73
PERS	0.0087	0.0069	15.1026	0.0779	0.0000	0.1433	0.8567	0.6
OTHERS	0.0017	0.0012	131.1107	0.2049	0.0000	0.0569	0.9431	0.8
TRUST	0.0004	0.0003	35.2929	0.0829	0.0000	0.0116	0.9884	0.95
SUMB	0.0131	0.0101	7.6548	0.0462	0.0002	0.0232	0.9766	0.84
FGS	0.0116	0.0085	8.2808	0.0532	0.0000	0.0416	0.9584	0.83
TBILLS	0.0191	0.0151	92.8433	0.0991	0.0000	0.0320	0.9680	0.88

Table 4.5.6: EU Aggregated forecasting table (1964:1 to 2005:1)

EQNS	*RMSE*	*MAE*	*MAPE*	*Thiel I Coeff*	*Bias Prop*	*Var Prop*	*Cov Prop*	*R^2*
LOANS	0.02407	0.01901	3.186498	0.020254	0.000013	0.037189	0.962798	0.73
SUMB	0.01646	0.013145	10.15622	0.058882	0.000718	0.03996	0.959322	0.72
FGS	0.01341	0.009503	9.05565	0.061278	0.000023	0.052797	0.94718	0.78
TBILLS	0.0206	0.016523	89.34777	0.106839	0.000008	0.37983	0.962009	0.86

Table 4.5.7: EU Disaggregated forecasting table (1964:1 to 2008:1)

EQNS	*RMSE*	*MAE*	*MAPE*	*Theil I Coeff*	*Bias Prop*	*Var Prop*	*Cov Prop*	*R^2*
LOANS	0.015997	0.012817	2.227711	0.013685	0.000026	0.069861	0.930113	0.73
GOVT	0.0138	0.0104	47.9957	0.1408	0	0.1415	0.8585	0.60
PUBS	0.0111	0.0083	16.4101	0.0979	0	0.066	0.934	0.77
PRIVS	0.021	0.0161	3.8556	0.0246	0	0.0509	0.9491	0.70
PERS	0.0109	0.0082	16.4993	0.092	0.0012	0.2709	0.7279	0.59
OTHERS	0.0021	0.0014	128.179	0.2502	0.0185	0.0441	0.9374	0.69
TRUST	0.0005	0.0003	33.4408	0.0902	0.0002	0.0115	0.9882	0.94
SUMB	0.0138	0.0105	8.2319	0.0498	0.0021	0.0005	0.9974	0.83
FGS	0.0117	0.0087	9.284	0.0549	0.002	0.0016	0.9964	0.86
TBILLS	0.0201	0.0158	86.6555	0.0999	0.0002	0.0264	0.9735	0.87

Table 4.5.8: EU Aggregated forecasting table (1964:1 to 2008:1)

EQNS	*RMSE*	*MAE*	*MAPE*	*Theil I Coeff*	*Bias Prop*	*Var Prop*	*Cov Prop*	*R^2*
LOANS	0.029242	0.02332	3.931399	0.025321	0.241236	0.009393	0.749371	0.67
SUMB	0.05698	0.029666	26.05439	0.214374	0.199656	0.290126	0.510217	0.70
FGS	0.021282	0.01662	15.13585	0.108554	0.551746	0.145421	0.302832	0.81
TBILLS	0.021263	0.017291	84.70375	0.10609	0.000001	0.038596	0.961402	0.86

Above forecasting statistics show that almost all equations with forecasting point of views are best except (a) Others and Tbills in disaggregated model for 1964:1 2008:1 (b) Tbills in aggregated model for 1964:1 2008:1 (c) Others and Tbills in disaggregated model for 1964:1 2005:1 and (d) Tbills for aggregated model for 1964:1 2005:1, as they have very high percentage of MAPE. Further, if you compare the forecasting statistics for disaggregated and aggregated models for the same period, we find there is no big difference among similar equations.

The equation for a given asset ratio, that provides the greater R-squared must have the lowest bias proportion. R squared values tell us the disaggregated model wins aggregated model for the in-sample period 1964:1 2005:1.Disaggregated model explains Loans better (0.77 against 0.73); Sumb better (0.84 against 0.72); and FGS better (0.83 against 0.78), and Tbills better (0.88 against 0.86). For the whole sample: (a) for Loans, R-squared is 0.73 for the disaggregated model and 0.67 for aggregated model; (b) for sumb, R-squared is 0.83 for disaggregated model and 0.70 for the aggregated model; (c) for FGS, R-squared is 0.86 for disaggregated model and 0.81 for the aggregated model; and (c) for Tbills, the R-squared is 0.87 for the disaggregated model and 0.86 for the aggregated model. In sums, we can say that the disaggregated models are superior in both in-sample and whole-sample periods.

4.6: Summary:

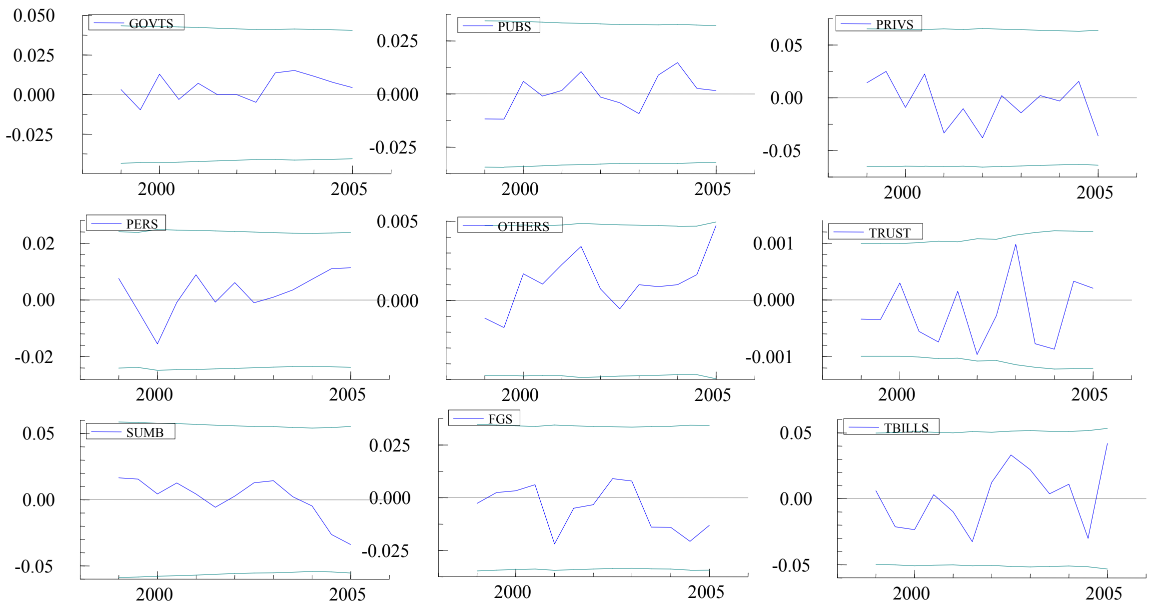
To investigate the portfolio behaviour of scheduled commercial banks of Pakistan, we have estimated various disaggregated static and dynamic models. We have found that the static unrestricted model is the best model among all potential static models on the basis of Log likelihood values but it has poor quality as R-squared and D-W statistics show that the explanatory variables do not explain most of the dependent variables and they have also suffer from autocorrelation. Therefore, to explain the banking behavior of Pakistani commercial banks, we have chosen dynamic model with separate total time deposit and total demand deposit with dummy. As this dynamic model wins over all the potential dynamic models in the sense of Log likelihood values and it has high R-squared and good residual properties.

We have also estimated various dynamic aggregated expected utility models in which we have aggregated all loans i.e Govt, Pubs, Pers, Privs, Others and Trust sectors loans, and remaining items are as it is. The basic idea is to see if there is a loss of information in explaining the items in the portfolio, and hence the total portfolio, in aggregating all loans, implying that they are perfect substitutes for the banks. We have also plotted different forecasting and other statistics to compare the best expected utility disaggregated and aggregated models within the sample period and out of the sample period. The comparison shows that the disaggregated model wins over aggregated model.

APPENDIX A

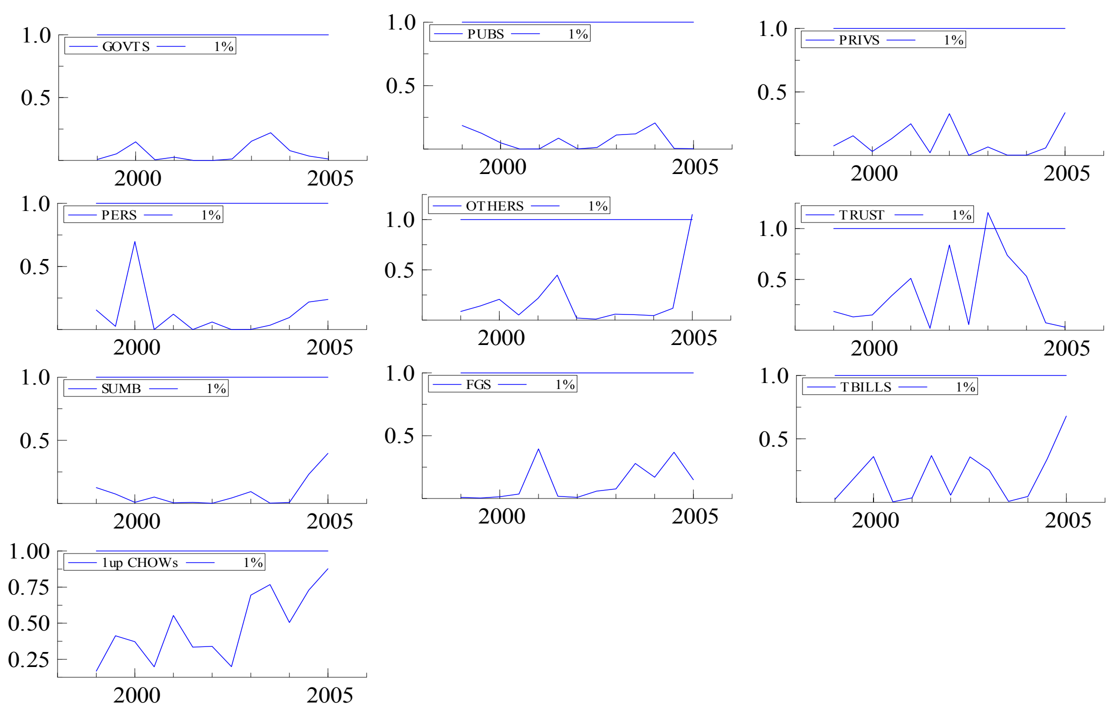
Graphs: The Recursive Analysis

1 step ahead residuals

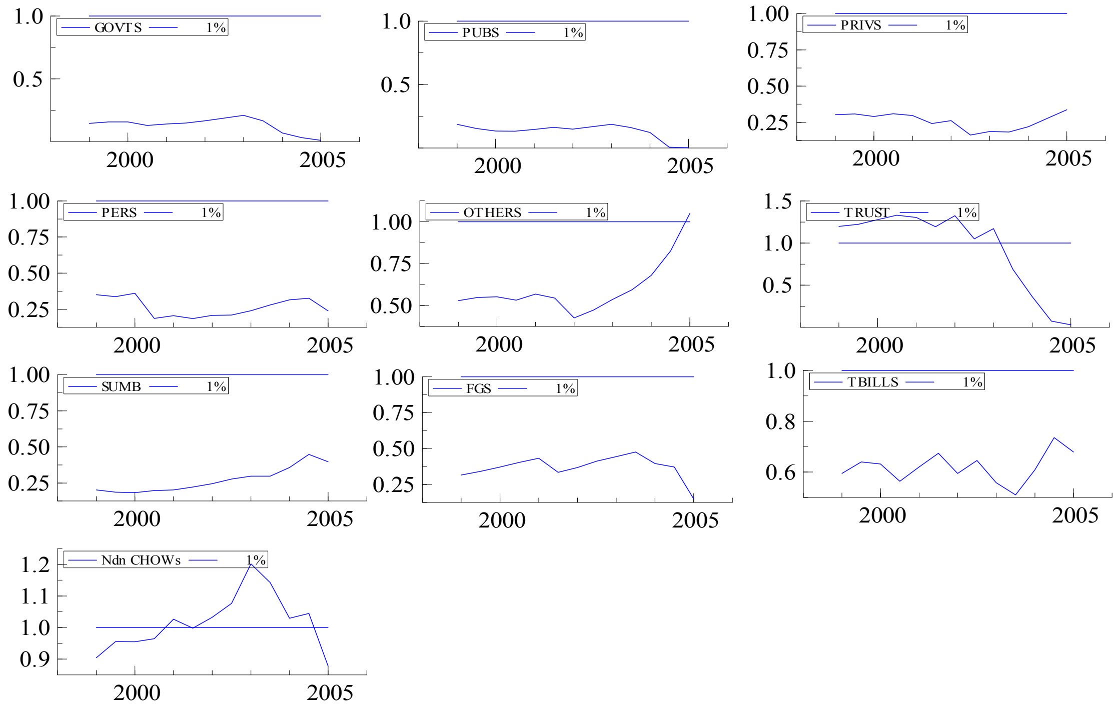


Chow Tests

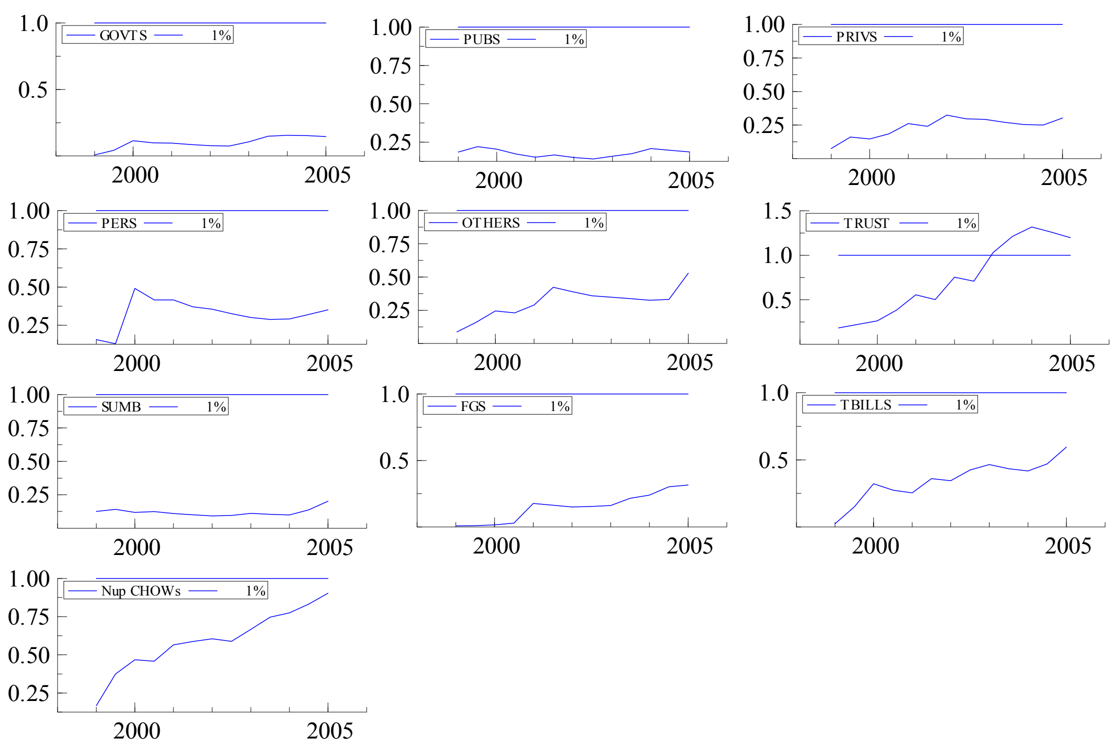
1 Step Chow test



Break Pont Chow Test



Forecast Chow test



CHAPTER FIVE

THE PRINCIPLE OF SAFETY FIRST AND BANK BEHAVIOR

5.1: Introduction:

In this chapter our study will focus on the banking sector portfolio behaviour based on the safety first principle of A.D Roy (1952). Individuals and institutions design the portfolio primarily to avoid a disaster level of outcome occurring. Roy (1952) argued that "there is close resemblance between economic life and navigation in poorly charted waters or manoeuvres in a hostile jungle. Decisions taken in practice are less concerned with whether a little more of this or of that will yield the largest net increase in satisfaction than with avoiding known rocks of uncertain position or with deploying forces so that, if there is ambush round the next corner, total disaster is avoided". In view of the above it is sensible to suppose that decision-makers are primarily interested in avoiding disaster or to secure safety. As a result, it is also sensible to suppose that investors/decision-makers is looking to minimise the probability of a portfolio return falling below a critical level; as Roy advocates.

The principle of safety first in various forms has been applied to the optimal hedge ratio (OHR) – with the aim of reducing risk. As number of future contracts to buy to hedge against the movements of the return in the spot market and the effectiveness of a hedging strategy is measured by the extent to which it minimises risk and maximizes excess return[1]. The principal of safety first has also been applied to the theory of risk insurance industry, to the theory of the firm under price uncertainty and to the problem of revenue rising under

[1] Prominent work on hedging can be seen in Cheung, Kwan and Yip (1990), Kolb and Okunev (1992,1993), Shailt (1995), Chen, Lee and Shrestha (2001) and Cotter and Hanly(2006)

uncertainty[2]. Such rules are important to commercial banks as well, as their main resources are deposit liabilities.

In this chapter, we will explore the implications of applying the principle of safety first to the modelling of bank portfolio behaviour. Section 5.2 presents a brief description of the principle and its application and describes the bank's optimal static and dynamic asset demand equations and derived under the principle which highly non-linear. Section 5.3 discusses specification of the model, gives details of the econometric methodology employed and also provides the data analysis. In Section 5.4 the empirical results from applying the model to Pakistani banks are reported. Section 5.5 ,we estimate the best aggregated dynamic model, where all loans has been aggregated into one, and provide the comparison between the best disaggregated and best aggregated models. Section 5.6 provides the summary of the chapter.

5.2: A Safety First Approach to Portfolio Behavior:

Roy principle is a rule for decision making in the context of portfolio selection behavior under the uncertainty in which decision makers have in mind some disaster level of returns (profit) and they behave so as to minimize the probability of the target variable (profit) falling below this threshold of disaster *D*.. With every possible action, there is the expected value of the gross return μ which is not certain. Thus, there is a quantity σ which is the standard error of μ .

[2] See Cramer (1930), Arzac (1976) and Dickinson, Driscoll and Ford (1984) respectively.

Further, mean return μ and its standard error σ are assumed to be known and can be obtained from the information about the past. For all feasible choice of action, given the values of μ *and* σ, we have the efficient mean-variance frontier as

(5.1) $f(\sigma, \mu) = 0$

As the investor knows nothing about the precise probability of the final return being a predetermined disaster level of D or less, Roy (1952) applied Tchebycheff inequality which permits us to place an upper bound on the probability of disaster. Tchebycheff's inequality states that if π is a random variable with mean μ and variance σ^2, then for any real number $\delta > 0$

(5.2) $\Pr(|\pi - \mu| \geq \delta) \leq \dfrac{\sigma^2}{\delta^2}$

Namely, the probability that the random variable, π, will differ from its mean, μ, by more than a fixed number, δ, is less than or equal to the ratio of its variance to the square of the fixed number. Let $\delta = \mu - D$, then we can rewrite (5.2) as

$$(\Pr(|\pi - \mu| \geq \mu - D) \leq \frac{\sigma^2}{(\mu - D)^2}$$

Since the inequality above applies to both tails of a probability distribution it must be the case that

$$(\Pr(\mu - \pi) \geq \mu - D) \leq \Pr(|\pi - \mu| \geq \mu - D \leq \frac{\sigma^2}{(\mu - D)^2}$$

which is similar to

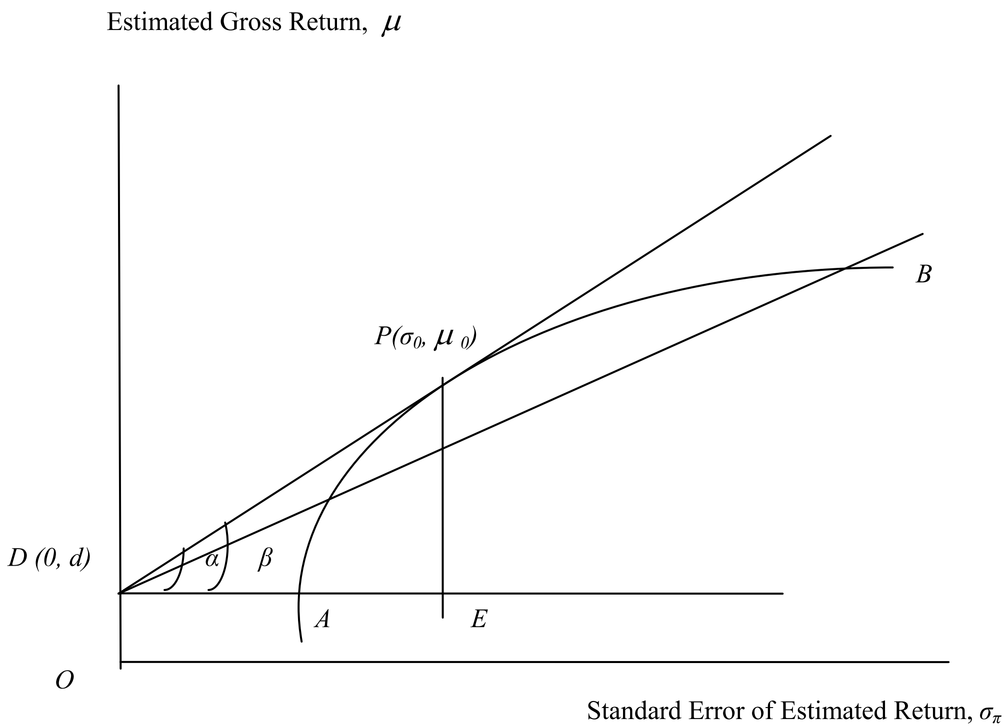
(5.3) $(\Pr(\mu - \pi) \geq \mu - D) = \Pr(\pi \leq D) \leq \dfrac{\sigma^2}{(\mu - D)^2}$

According to Roy, the investor's objective is to minimize the probability of disaster, $\Pr(\pi \leq D)$, which can be achieved by minimizing, $\dfrac{\sigma^2}{(\mu - D)^2}$, on maximizing

$\frac{(\mu - D)^2}{\sigma^2}$. Hence, the true principle of Safety First can be obtained from the maximization of this quantity. If σ^2 is constant for all values of μ, then the maximisation of $\frac{(\mu - D)^2}{\sigma^2}$ is equivalent to maximising expected return for any given disaster level. That suggest the above procedure based upon the Principle of Safety First may be regarded as a generalisation of profit maximisation under uncertainty.

The safety first principle can be presented by a geographical demonstration. In figure 1, the $f(\sigma, \mu) = 0$ curve describes the efficient set. If an investor desires to avoid an outcome of *D* or worse, the optimal portfolio is at the point *P* where the line drawn from the point *D (0, d)* is tangent to the $f(\sigma, \mu) = 0$ curve. At point *P*, the upper bound of the probability of disaster, $\frac{\sigma^2}{(\mu - D)^2}$, is minimized, or $\frac{(\mu - D)^2}{\sigma^2}$ is maximized. This means that the investor can have the upper bound of the probability of *D* or worse happening as small as possible from taking the action which is expected to have the gross return μ_0.

Figure 1: The graphical presentation of the best μ and σ combination



5.2.1: The Principle of *Safety First* and Commercial Bank Portfolio Behaviour

The following model is formulated to apply the safety first principle for the analysis of bank portfolio behavior. According to this model, bank is assumed to concern that its actual return at the end of the decision period from a given portfolio, π, should not be less than a predetermined level, *D*. This predetermined level of return could be the target set by the bank to assess the performance of its management team, or it could be that level of return the management deems necessary for the bank to the break even. Unlike the individual investor the bank is not able to determine the level of each and every asset/liability. As expected utility maximization model, we partition the bank's balance sheet into choice and non choice items. We assume that liabilities are negative assets, and then the bank's actual return from a given portfolio is its profit defined as,

$$(5.4)\ \pi = A_1^{'}r_1 + A_2^{'}r_2$$

Where A_1 is the ($m\,x$ 1) vector of choice set assets items, r_1 is the ($m\,x$ 1) vector of return on the choice items, A_2 a (n-m x 1) vector of non-choice items(where n>m) and r_2 is the (n-$m\,x$ 1) vector of rates of return on the non-choice items. Since the actual level of assets and liabilities and their returns at the end of each decision period are not known at the moment of decision, the actual return from a given portfolio is uncertain and the bank will have to form expectations about it. However, the bank is assumed to be able to estimate from the past data only the expected values of π, μ_π and its variance σ_π^2

Assuming that the rate of return on assets/ liabilities are not correlated with the levels of these assets/liabilities and that only the rates of return within the choice items are correlated with each other, the expected return on a given portfolio and its variance can be written as,

$$(5.5)\ \mu_\pi = \hat{A}'_1\, e_1 + \hat{A}'_2\, e_2 \qquad \text{and;} \qquad \sigma_\pi^2 = \hat{A}'_1\, \Omega_{11}\, \hat{A}_1$$

Where $\hat{A}'_1, \hat{A}'_2, e_1, e_2, \Omega_{11}$ are the expected values of A_1, A_2, r_1, r_2 and the variance covariance matrix of the rates of return on the choice items respectively.

To obtain the bank asset demand equation, the bank is assumed to minimize: $p_r(\pi \le D) \le \dfrac{\sigma_\pi^2}{(\mu_\pi - D)^2}$

Or

$$C = \frac{(\mu_\pi - D)^2}{\sigma_\pi^2}$$

To solve for the bank's optimal portfolio for the choice assets, we first derive the bank's efficient mean variance frontier along which the optimal value of the μ_π is located.

Accordingly, $\hat{A}'_1$ has to be chosen to minimize the level of a total risk subject to a given portfolio mean return (profit) and the bank's balance sheet constraint. That is minimizing

(5.6) $\sigma_\pi^2 = \hat{A}'_1 \, \Omega_{11} \, \hat{A}'_1$

Subject to

(5.7) $\mu_\pi = \hat{A}'_1 \, e_1 + \hat{A}'_2 \, e_2$

(5.8) $\hat{A}'_1 \, i_1 + \hat{A}'_2 \, i_2 = 0$

Forming the Lagrangean, we have

(5.9) $L = \hat{A}'_1 \, \Omega_{11} \, \hat{A}_1 + 2\lambda_1 (\mu_\pi - \hat{A}'_1 \, e_1 - \hat{A}'_2 \, e_2) + 2\lambda_2 (\hat{A}'_1 \, i_1 + \hat{A}'_2 \, i_2)$

And then differentiating it with respect to the choice set vector $\hat{A}'_1, \lambda_1$ *and* λ_2, we obtain the following first order conditions.

(5.10) $\dfrac{\partial L}{\partial \hat{A}_1} = 2\Omega_{11} \hat{A}_1 - 2\lambda_1 e_1 + 2\lambda_2 i_1 = 0$

(5.11) $\dfrac{\partial L}{\partial \lambda_1} = 2\mu_\pi - 2\hat{A}'_1 \, e_1 - 2\hat{A}'_2 \, e_2 = 0$

(5.12) $\dfrac{\partial L}{\partial \lambda_2} = 2\hat{A}'_1 \, i_1 + 2\hat{A}'_2 \, i_2 = 0$

By rearranging (5.10), we have.

(5.13) $\hat{A}_1 = \Omega_{11}^{-1} (\lambda_1 e_1 - \lambda_2 i_1)$

Where Ω_{11}^{-1} is the inverse of Ω_{11}. This solution vector involves the two undetermined Lagrangean multipliers. To eliminate them, we substitute (5.13) for $\hat{A}_1$ into equations (5.6)-(5.8), so that

(5.14) $\sigma_\pi^2 = (\lambda_1 e_1 - \lambda_2 i_1)' \Omega_{11}^{-1} (\lambda_1 e_1 - \lambda_2 i_1)$

(5.15) $\mu_\pi = (\lambda_1 e_1 - \lambda_2 i_1)' \Omega_{11}^{-1} e_1 + \hat{A}_2' e_2)$

(5.16) $\hat{A}_2' = -(\lambda_1 e_1 - \lambda_2 i_1)' \Omega_{11}^{-1} i_1$

By expanding (5.14) and utilising (5.15) and (5.16), we have

(5.17) $\sigma_\pi^2 = \lambda_1 (\mu_\pi - \hat{A}'_2 e_2) - \lambda_2 \hat{A}'_2 i_2 = 0$

From equation (3.15) and (3.16), λ_1 and λ_2 can be solved as,

(5.18) $\lambda_1 = \frac{1}{d}[i_1' \Omega_{11}^{-1} i_1 (\mu_\pi - d_1) + i_1' \Omega_{11}^{-1} e_1 d_2]$

(5.19) $\lambda_2 = \frac{1}{d}[e_1' \Omega_{11}^{-1} e_1 d_2 + e_1' \Omega_{11}^{-1} i_1 (\mu_\pi - d_1)]$

Where

$d = (e_1' \Omega_{11}^{-1} e_1)(i_1' \Omega_{11}^{-1} i_1) - (e_1' \Omega_{11}^{-1} i_1)(i_1' \Omega_{11}^{-1} e_1)$

$d_1 = \hat{A}'_2 e_2$

$d_2 = \hat{A}'_2 i_2$

By substituting the expression λ_1 and λ_2 from equations (5.18) and (5.19) into (5.17) we find the efficient mean-variance frontier to be

(5.20) $d\sigma_\pi^2 - \mu_\pi^2 (i_1' \Omega_{11}^{-1} i_1) + 2\mu_\pi (i_1' \Omega_{11}^{-1} i_1 d_1 - i_1' \Omega_{11}^{-1} e_1 d_2) - i_1' \Omega_{11}^{-1} i_1 d_1^2 + 2 i_1' \Omega_{11}^{-1} e_1 d_1 d_2 - e_1' \Omega_{11}^{-1} e_1 d_2^2 = 0$

According to equation (5.20), all of the possible portfolios on this frontier are efficient. In addition, by dividing equation (5.20) by $i_1' \Omega_{11}^{-1} i_1$, we see that it is a hyperbolic function in the μ_π - σ_π^2 space

(5.21) $d\alpha\sigma_\pi^2 + (\beta^2 - \gamma) d_2^2 = [\mu_\pi - (d_1 - \beta d_2)^2]$

where

(5.22) $\alpha = \dfrac{1}{i_1' \Omega_{11}^{-1} i_1}$

(5.23) $\beta = \frac{i_1^{'}\Omega_{11}^{-1}e_1}{i_1^{'}\Omega_{11}^{-1}i_1}$ and

(5.24) $\gamma = \frac{e_1^{'}\Omega_{11}^{-1}e_1}{i_1^{'}\Omega_{11}^{-1}i_1}$

All portfolios along this frontier are efficient. If the individual investor locates his preferred position on the frontier then immediately the optimal combination of μ_{π}, σ_{π}^2 is specified. By substituting these values in (5.18), (5.19) and (5.13), it is yield the bank's optimal asset holdings, $\hat{A}_1$. After some algebraic manipulation we obtain the bank's optimal static asset demand equations as,

(5.25) $\hat{A}_1 = -\frac{\Omega_{11}^{-1}[e_1 - (d_1 - D)/d_2\ i_1]}{[e_1 - (d_1 - D)/d_2 i_1]'\Omega_{11}^{-1}i_1} d_2$

This shows that the asset demand equation differ from the expected utility maximisations. A detailed derivation of the above system of equations is provided in the *Appendix A* to the chapter. A non-trivial solution requires that the inverse matrix Ω_{11}^{-1} exists. Let m_{ij} be the cofactor of the (*j,i*)th element of Ω_{11}, then

(5.26) $\Omega_{11}^{-1} = \frac{1}{|\Omega_{11}|} M_{11}$

Where $|\Omega_{11}|$, the determinant of Ω_{11} (positive semi-definite), and M_{11} is the adjugate matrix of Ω_{11} with m_{ij} being its (*j,i*)th element. The inverse matrix Ω_{11}^{-1} exists if and only if $|\Omega_{11}|$ is positive definite. That is, all the rates of return on the choice items are not linearly dependent. In other words, $\sigma_{ii} > 0$ for all *i*, which can be implied that there are no riskless assets exist in the choice set. Further we define

(5.27) $m_i = \sum_{j=1}^{m} m_{ij}$

as the row sum of the adjugate matrix M_{11} . Since Ω_{11} is a symmetric variance and covariance matrix, M_{11} is also symmetric, so that we have

$$(5.28)\, m_i = \sum_{j=1}^{n} m_{ij} = \sum_{j=1}^{n} m_{ji}$$

which is special case where Ω_{11} is diagonal so that M_{11} is also diagonal, reduces to

$$(5.29)\, m_i = m_{ii}$$

Thus, if the i^{th} element $\hat{A}_1$ and its expected return, e_1, are defined as $\hat{a}_{1i}$ and e_{1i}, respectively, the bank's optimal holding of asset i can be expressed as

$$(5.30) \quad \hat{a}_{i1} = -\frac{m_{i1}[e_{11} - (d_1 - D)/d_2] + m_{i2}[e_{12} - (d_1 - D)/d_2] + ... + m_{im}[e_{1m} - (d_1 - D)/d_2]}{m_1[e_{11} - (d_1 - D)/d_2] + m_2[e_{12} - (d_1 - D)/d_2] + ... + m_m[e_{1m} - (d_1 - D)/d_2]} d_2$$

The demand equations presented in equation (5.30) are nonlinear with the denominators are the same for all asset demand equations since the denominator is independent of the subscript *i.* It is interested to note that the quantity $(d_1\text{-}D)/d_2$ is subtracted from each and every expected rate of return on the choice items. Further, because $d_1 = \hat{A}'_2\, e_2$ and $d_2 = \hat{A}'_2\, i_2$, where $\hat{A}'_2\, e_2$ are the expected levels and expected rate of return of non choice items respectively. Thus equation (5.30) shows that , the bank's optimal holding on choice assets are not only depends on the expected rates of return on choice items and the riskiness of the returns (i.e, the covariance) but also the expected return rates and the expected level of non choice items. That is, the safety first model includes the effects of the exogenous variables into the decision making and allow us to examine how the changes in non choice items can affect the optimal level of choice items.

In addition, it is assumed that all choice assets are contained in $\hat{A}_1$, and all liabilities which are treated as negative assets are included in $\hat{A}_2$, thus, $d_2 = \hat{A}'_2 i_2$ is the total disposable fund that the bank can invest in the choice assets and $d_1 = \hat{A}'_2 e_2$ is the net cost of the bank's liabilities, as bank has to pay the interest on its liabilities. Therefore, the unit cost *(c_n)* of disposable funds or the unit cost of liabilities can be expressed as

$$(5.31)\, c_n = \frac{d_1}{d_2} = \frac{\hat{A}'_2 e_2}{\hat{A}'_2 i_2}$$

and the disaster rate of return *(r_c)*required for each unit of liabilities can be written as

$$(5.32)\, r_c = -\frac{D}{d_2}$$

The bank's demand for asset (*i*) can be written as

$$(5.33)\, \hat{a}_{i1} = -\frac{m_{i1}[(e_{11}-c_n)-r_c]+m_{i2}[(e_{12}-c_n)-r_c]+......+m_{im}[(e_{1m}-c_n)-r_c]}{m_1[(e_{11}-c_n)-r_c]+m_2[(e_{12}-c_n)-r_c]+......+m_m[(e_{1m}-c_n)-r_c]}d_2$$

In parentheses, it shows that the net expected rates of return *(e_{1i}-c_n)* for $i = 1,2,...m$, i.e, the gross expected rates of return minus the net unit cost of disposable funds. To decide which asset should hold in the portfolio, bank considers whether the net expected rate of return on the asset in equation is greater than the disaster rate of return *(r_c)*, while the net expected rates of return of all other assets fell to the disaster rate of return. Should the net expected rate of return on this particular asset be greater than the disaster rate of return, the bank would then hold some of its total disposable funds in this asset. In contrast, for the asset which its net expected rate of return is less than the disaster rate of return, the bank would then eliminate this particular asset from its portfolio. The proportion of each asset in the bank's portfolio depends on the size of the difference of between the expected rate of return on this particular asset and the disaster rate of return, and the variance and covariance of the expected return.

Similar to the case of an individual investor the bank's disaster rate of return depends only upon the predetermined level of return, D and disposable funds. Further, in contrast to the individual investor, the net rate of the return on an asset depends not only on the gross expected rate of return on that particular asset but also on the net unit cost of the bank's disposable funds, which in turn depends upon the levels of the non-choice items as well as their expected rates of return. That is, both the level of non-choice items and the expected rates of return on them will affect the bank's optimal holdings for the choice items.

In expected utility framework, it is assumed that the bank's demand for an asset will depend only upon the expected rate of return on this particular asset when the rates of the return on the choice items are not correlated with each other. This property does not hold under the Safety First Principle. If the rates of return on the choice items are not correlated with each other, i.e. if Ω_{11} is diagonal, then given the definition of m in equation (5.33) will collapse to

$$(5.34)\ \hat{a}_{i1} = -\frac{m_{ii}[(e_{11} - c_n) - r_c]}{m_1[(e_{11} - c_n) - r_c] + m_2[(e_{12} - c_n) - r_c] + ... + m_m[(e_{1m} - c_n) - r_c]} d_2$$

Its mean even when the rates of return on the choice assets are not correlated with each other, the demand for one asset still depend on its own expected rate of return as well as the expected rates of return on all assets in the choice assets.

By putting the values of $c_n, r_c,$ from equations (5.31), (5.32) and (5.26) in equation (5.25), we have following the static asset demand equation of the bank.

$$(5.35)\ \hat{A}_1 = -\frac{M_{11}[e_1 - (c_n + r_c)i_1]}{[e_1 - (c_n + r_c)i_1]' M_{11} i_1} d_2$$

$r_c,$ and c_n are scalars so that the same constant will be subtracted from each expected rate of return on the choice item of the portfolio. We have set out the equations as vectors of the levels of the assets and then (because that levels are I(1)) we have estimated the equations in terms of shares/ratios which is assets to d_2. Thereafter, we have worked with the ratio version and when putting the system into dynamic form we have written out that form for the ratios, not for the levels. If we divide both sides of (5.35) equation by d_2, we can rewrite the bank's system of asset demand equations as:

$$(5.36)\ \hat{A}_1 = -\frac{M_{11}[e_1 - (c_n + r_c)i_1]}{[e_1 - (c_n + r_c)i_1]' M_{11} i_1}$$

as

$$\hat{A}_1 = \frac{A_1}{d_2}$$

As d_2 is the total disposable fund and the bank can invest in the choice assets and $\hat{A}_1$ as the vector of the share/ratio of each asset in the choice portfolio. Therefore, above equation is the system of asset demand equations in terms of shares/ratios.

5.2.2: The Bank's Portfolio Adjustment:

The bank's asset demand equations in (5.36) are static equilibrium solutions which represent the bank's long run equilibrium solutions. In the absence of transaction cost and market deficiencies the bank will always adjust its portfolio towards the optimal asset holdings. But in reality, transaction cost and market deficiencies do exist and, therefore, a bank may be incapable of adjusting optimally its portfolio. Equivalently, the allocation of its available funds at the end of a decision period may not be desired or the implied by the optimal demand functions. The bank, obviously, will continue to adjust its portfolio during the next decision period in order to reach the optimal asset levels. Let us assumed that the bank's adjustment process similar to the expected utility framework in previous chapter.

$$(5.37)\quad \Delta\hat{A}_{1,t} = \hat{A}_{1,t} - \hat{A}_{1,t-1} = L(\hat{A}_{1,t} - \hat{A}_{1,t-1})$$

Where $\Delta\hat{A}_{1,t}$ is (1xn) vector of actual change in choice set item from t-1 to t time period. $(\hat{A}_{1,t} - \hat{A}_{1,t-1})$ represents a (nx1) vector of difference between desired and actual holdings of choice set items. By substituting (5.35) into (5.37) yield the bank's dynamic asset demand equations as:

$$(5.38)\ \hat{A}_1 = -\frac{LM_{11}[e_1 - (c_n + r_c)i_1]}{[e_1 - (c_n + r_c)i_1]'M_{11}i_1} d_2 + (I - L)\hat{A}_{1,t-1}$$

Or

$$(5.39)\ \hat{A}_1 = -\frac{G\ [e_1 - (c_n + r_c)i_1]}{[e_1 - (c_n + r_c)i_1]'M_{11}i_1} d_2 + Z\hat{A}_{1,t-1}$$

Where

$G = LM_{11}$ &

(I-L)=Z

Equation (5.39) represents the bank's short-run asset demand functions.

5.3: Specification of the Models, Methodology and Data Analysis:

Equations (5.36) and (5.39) represent static and dynamic models, respectively, for the portfolio behaviour of an individual bank. To estimate these models we have to use the same definitions of choice *(A_1)* and non choice *(A_2)* items in table (5.3.1) and make following assumptions regarding aggregation over banks. Specifically, we assume that

- The disaster return D is zero for all banks (therefore $r_c = -\frac{D}{d_2}$=0 in equations 4.36 and 4.39)
- All banks possess the same decision period and maximize the same objective function, i.e, $C = \frac{(\mu_\pi - D)^2}{\sigma_\pi^2}$

- Future expectations of assets' rate of returns and the subjective variance-covariance matrix are identical across all.
- The same transaction and disequilibrium costs are faced by all banks.
- The vectors of expected rates of return on the choice variables *e,* and the expected value of the non-choice variables are unobservable. We approximate the expected rates of return by the actual rates "*r*" and replace the expected values of the non-choice items by their actual values A_2.

The assumption one is implies that every bank regards break even as the critical point and will try to minimise the probability that actual return from their portfolios fall short of the costs of funding. Such an assumption is not as restrictive as it may seem at first sight. As we can see from the asset demand equations in (5.25), the same quantity D/d_2 is subtracted from each and every expected rate of return of choice asset. Thus, whatever the value of *D* it will not alter the relative attractiveness of the assets in the portfolio.

On the above assumptions, we may sum over the *n* commercial banks of Pakistan so that we can use consolidated balance sheet data. Expanding the static and dynamic equations (5.36) and (5.39), respectively, we have;.

$$(5.40)\quad A_{1t} = -\frac{m_{i1}(r_{11}-c_n)+m_{i2}(r_{12}-c_n)+......+m_{im}(r_{1m}-c_n)}{m_1(r_{11}-c_n)+m_2(r_{12}-c_n)+......+m_m(r_{1m}-c_n)}d_2+\varepsilon_t$$

and

$$(5.41)\quad A_{1,t} = -\frac{g_{i1}(r_{11}-c_n)+g_{i2}(r_{12}-c_n)+......+g_{im}(r_{1m}-c_n)}{g_1(r_{11}-c_n)+g_2(r_{12}-c_n)+......+g_m(r_{1m}-c_n)}d_2+Z\hat{A}_{1,t-1}+\varepsilon_t$$

Actual behaviour may depart from the theoretical behaviour randomly and we assume that the vector of random errors ε_t enter the demand equations additively. We also assume that in both the static and dynamic equations they are normally distributed random variables with mean zero.

The following restrictions apply to the system of equations in (5.40) and (5.41)

(1) $m_i = \sum_{j=1}^{n} m_{ij} = \sum_{j=1}^{n} m_{ji}$

(2) $g_i = \sum_{j=1}^{n} g_{ij} = \sum_{j=1}^{n} g_{ji}$

(3) $i' Z = 0$

The first and second restriction are accumulating restrictions that require that m_i (g_i) equal the sum of all elements in the *ith* row of the adjugate matrix M_{11} (G). Given the symmetry of the adjugate matrix, the accumulated restrictions also imply that m_i (g_i) be equal to the sum of all elements in the *ith* column of M_{11} (G).Restriction three is actually about the Cournot aggregation condition and says that the column sums of the lagged endogenous variable response matrix are zero.

5.3.1: Methodology, Data and Their Properties:

Full Information Maximum Likelihood (FIML) technique is employed for the estimation of the coefficients of the system's equations. FIML estimator is consistent in non-linear systems of equations if ε is normally distributed but is generally inconsistent if ε is not normal, as shown in Amemiya (1977) and (1983). FIML is the only known efficient estimator for models that are non-linear in their parameters

To estimate the static and dynamic equations in safety first principle, we have to divide balance sheet of scheduled banks of Pakistan into choice (endogenous) and non-choice (exogenous) items. Table 5.3.1 gives full presentation of both types of variables where as definition of interest rates are same as provided information in chapter two.

Table 5.3.1: Choice and Non Choice Items of the Pakistani Banks

Notation	***Status***	***Description***
Panel A : Balance Sheet		
Assets		
GOVTS	*Endogenous*	*Loans to the Govt.Sector*
PUBS	*Endogenous*	*Loans to the Public Sector*
PRIVS	*Endogenous*	*Loans to the Private Sector*
PERS	*Endogenous*	*Loans to the Personal Sector*
OTHERS	*Endogenous*	*Loans to the Others Sector*
TRUST	*Endogenous*	*Loans to the Trust Funds & Non-Profit Org.*
PGS	*Exogenous*	*Provincial Govt. Securities*
SUMB	*Endogenous*	*Borrowing from, SBP*
FGS	*Endogenous*	*Federal Govt. Securities (Bonds)*
TBILLS	*Endogenous*	*Treasury Bills*
CASH	*Endogenous*	*Cash*
Liabilities		
CAPITAL	*Exogenous*	*Capital*
RESERVE	*Exogenous*	*Reserve*
CAPRES	*Exogenous*	*Capital & Reserve*
TTD	*Exogenous*	*Total Time Deposit*
TDD	*Exogenous*	*Total Demand deposits*
TDTL	*Exogenous*	*Total Demand and Time Deposit*
Panel B: Rates of Return on the Asset		
EFORGOVTS	*Exogenous*	*(r11-cn) = (Wag – Cn)*
EFORPUBS	*Exogenous*	*(r12-cn) = (Wap - Cn)*
EFORPRIVS	*Exogenous*	*(r13-cn) = (Wapr - Cn)*
EFORPERS	*Exogenous*	*(r14-cn) = (Wapl - Cn)*
EFOROTHERS	*Exogenous*	*(r15-cn) = (Waoh –Cn)*
EFORTRUST	*Exogenous*	*(r16-cn) = (Wat – Cn)*
EFORSUMB	*Exogenous*	*(r17-cn) = (Cmr – Cn)*
EFORFGS	*Exogenous*	*(r18-cn) = (Gbyld - Cn)*
EFORTBILLS	*Exogenous*	*(r19- cn) = (Sixmtbr - Cn)*
EFORCASH	*Exogenous*	*(r20-cn) = (Infl – Cn)*

In order to get static and dynamic equations' estimation, we have to divide both side the equation by d_2 (as we have seen in equation (5.36).Its mean endogenous variables will be divided by d_2 (where as d_2 is consist of Time Deposit + Demand Deposit +Capital +Reserves-PGS) and notation $\hat{A}_{1t}$ in static and dynamic equations (5.40) & (5.42) (represents endogenous variables in ratio form after divided by d_2). Another part of the static & dynamic equation is $c_n = \frac{d_1}{d_2}$ which is subtracted from all interest rates in numerator and denominator.

In our case *Cn* = (deposits *its rate – PGS* its rate)/ (Time Deposit + Demand Deposit +Capital +Reserves-PGS).

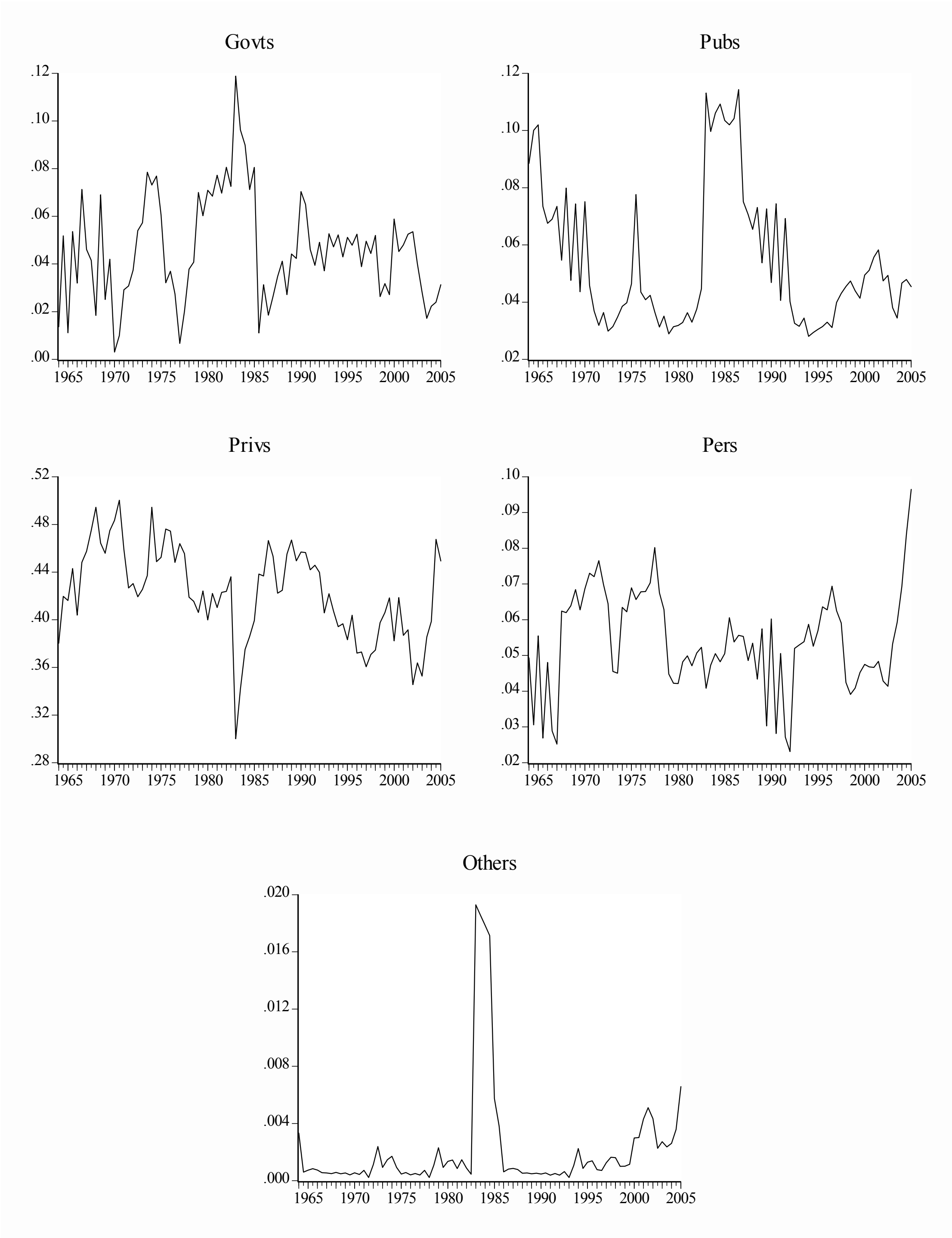
In order to avoid spurious regression, there are several ways of testing for the existence of a unit root. We conduct augmented Dickey-Fuller (ADF), Philips-Perron and Perron's (1997) unit root test to test the null hypothesis that a series contains a unit root. So, ADF and Philips-Perron confirm (in tables 4.3.2 & 4.3.3 in chapter four) that all endogenous and interest rate variables are I(0) processes. Here, we are also providing table 5.3.2 for unit root test for interest rates (Efors) variables which shows that these variables are I(0) processes in ADF and Philips-Perron tests.

5.3.2: Unit Root Tests: Efors

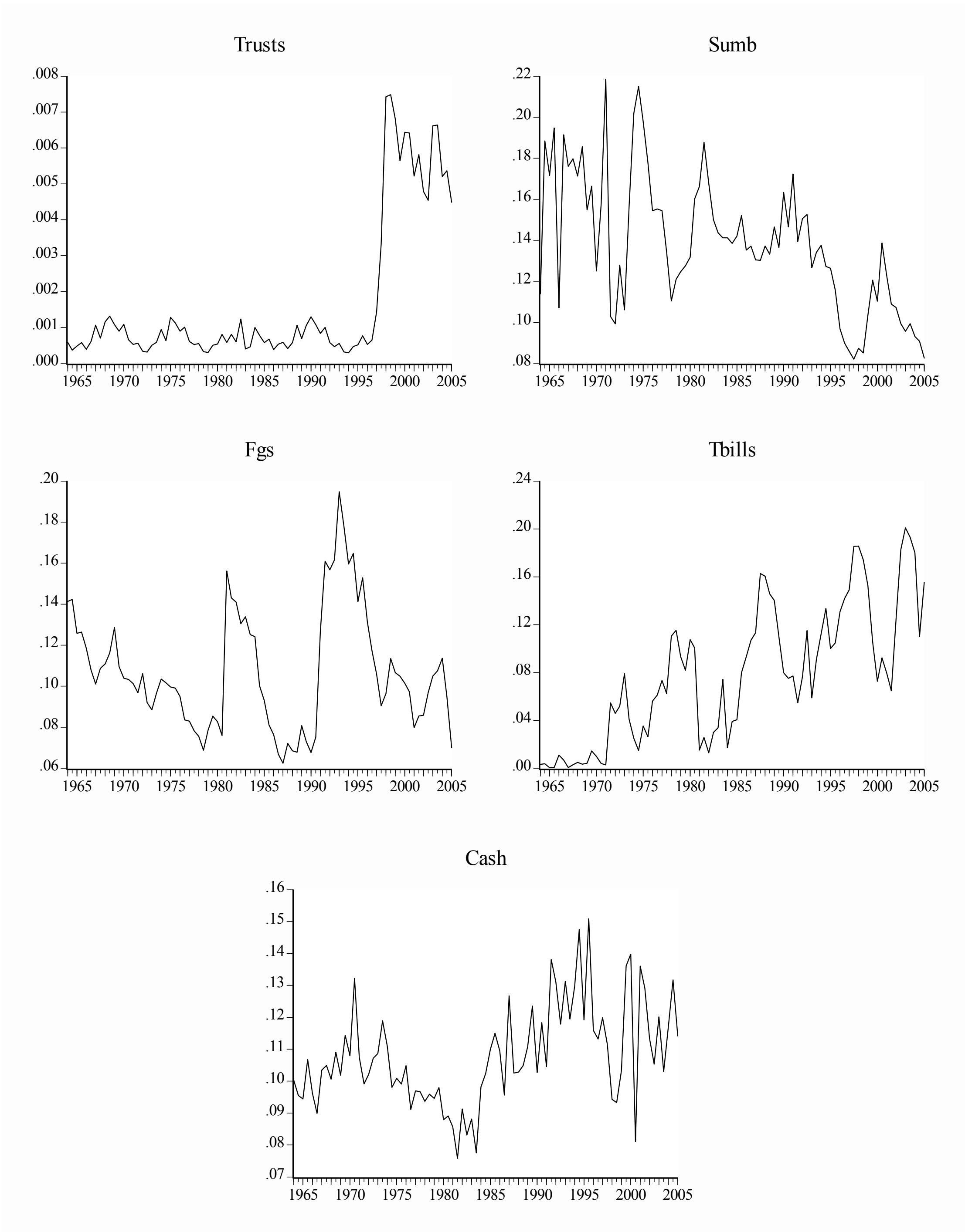
Efor	*Unit root tests: t-statistics and probabilities*
	ADF
eforgovt	*-4.65053 (0.0003)*
eforpubs	*-3.67876 (0.0062)*
eforprivs	*-3.60329 (0.0077)*
eforpers	*-2.65913 (0.0856)*
eforothers	*-3.31341 (0.0174)*
efortrust	*-3.57059 (0.0085)*
eforsumb	*-4.24255 (0.001)*
eforfgs	*-3.2984 (0.0181)*
efortbills	*-2.88463 (0.0515)*
	Perron: Structural Break test, Model AO
eforcash	*Method UR: -4.8 (0.05), I(0) with a break at 1990s1;* *Methods Studabs and Stud: -4.72 (0.05), I(0) with a break at 1989s1*

Further, the descriptive statistics of endogenous and interest rates (*Efors*) are given in *Appendix B* and Graphic presentation of endogenous variables and interest rates *(Efors)* is given below in figures (5.3.1) & (5.3.2).

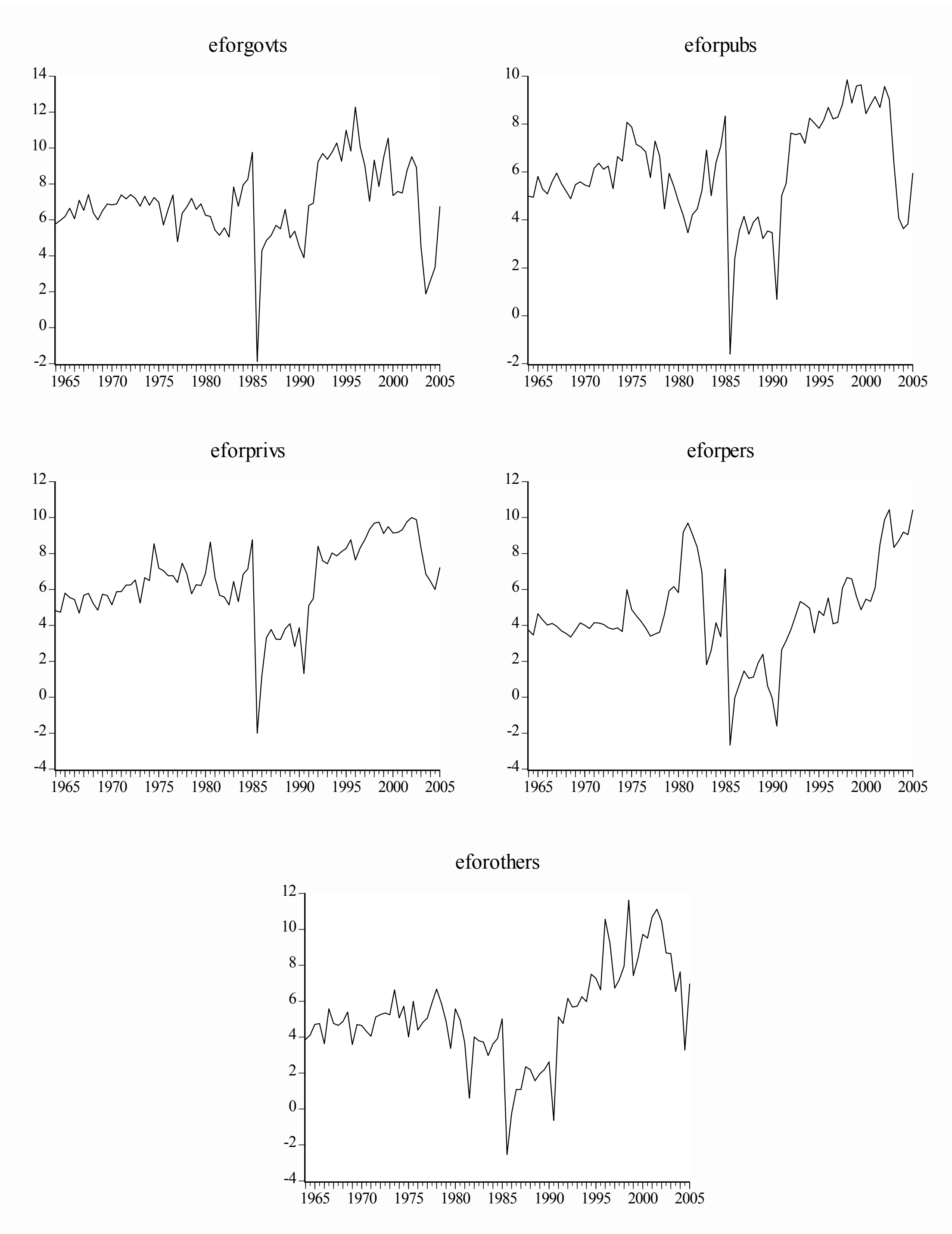
Figures 5.3.1: endogenous variables (Data Section: Asset Ratios Rupees in Millions)



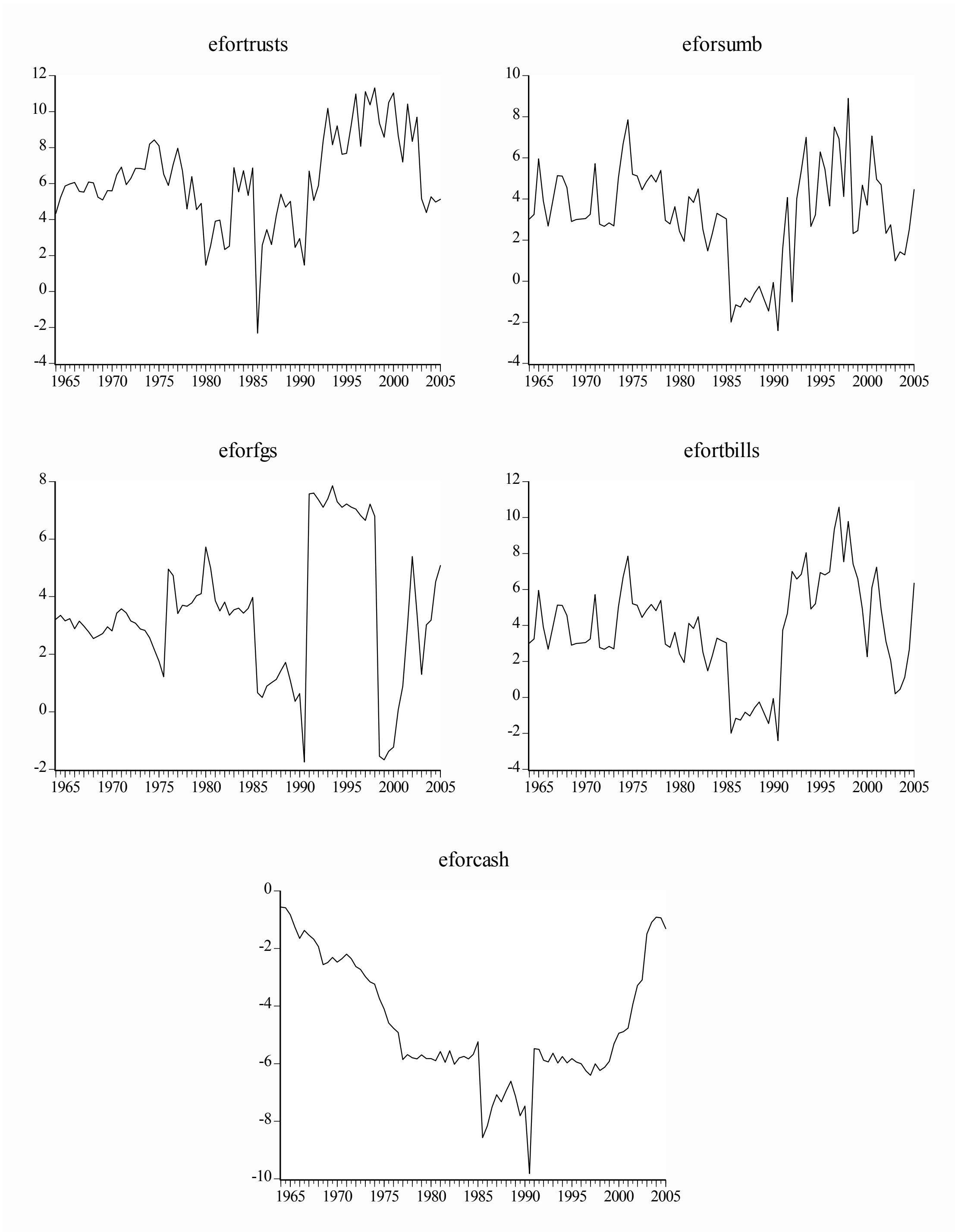
Endogenous variables (Asset Ratios Rupees in Millions : continued)



Figures 5.3.2: ***Efors*** **variables (the net returns in percent: the "efors")**



***Efors* variables (the net returns in perent: the "efors"): Continued**



5.4: Discussion of Empirical Results:

We have estimated various safety first static and dynamic models in this section. The type of estimated static models are, static model itself or static unrestricted model, static restricted model with symmetry, static restricted model with sums *Gi* and static restricted model with symmetry and sums *Gi* . Similarly, we have estimated dynamic unrestricted model, dynamic restricted model with symmetry, dynamic restricted model with symmetry and sums *Gi* . The analysis of model is given in table 5.4.1.

Table 5.4.1: Analysis of Models

Models	*Log-Likelihood*	*Restrictions*	*LR-Test*	*Results*
	Static Models			
Model 1	2141.92	*None*		
Model 2	2080.27	*Symmetry*	$123.3>\chi^2 = 48$	*Rejected*
Model 3	2021.16	*Sum*	$241.5>\chi^2 = 16.9$	*Rejected*
Model 4	1776.75	*Sym+*	$728.34>\chi^2 =60$	*Rejected*
	Dynamic Models			
Model 5	2415.39	*None*		
Model 6	2404.46	*Symmetry*	$21< \chi^2= 48$	*Accepted*
Model 7	1333.23	*Sym +*	$2164.32> \chi^2=60$	*Rejected*

Model 1: Static Unrestricted Model; **Model 2**: Static Restricted Model with Symmetry; **Model 3**: Static Restricted Model with Gi (Sums); **Model 4**: Fully Restricted Static Model with Symmetry and Gi restrictions; **Model 5**: Dynamic Unrestricted Model; **Model 6**: Dynamic Restricted Model with Symmetry; **Model 7**: Fully Restricted Dynamic Model with Symmetry and Gi restrictions.

Above analysis in table 5.4.1 show that the Model 1 as in equation (5.40) and Model 6 as in equation (5.41) are the best models in safety first static and dynamic models respectively.

The best static unrestricted model 1 has poor quality as R^2 and D-W statistics show in table 5.4.2 that the explanatory variables do not explain most of the dependent variables and they have also autocorrelation problem.

Table 5.4.2: Statistics for Static Unrestricted Model

EQNS	*R^2*	*D-W*
GOVTS	0.17	1.18
PUBS	0.41	0.88
PRIVS	0.28	0.82
PERS	0.19	0.81
OTHERS	0.11	0.51
TRUST	0.67	1.44
SUMB	0.4	1.43
FGS	0.33	0.51
TBILLS	0.54	1.25

As noted in table 5.4.1 the dynamic version model 6, is one the best models among all potential models in the sense of Log likelihood and we have tested and explained in this chapter a dynamic (with symmetry) model, which is more statistically stable than the static system. It is also superior to the best static unrestricted model 1, as it has high R^2, no AR in residual, no ARCH in residual, and the covariance matrix of the residuals indicates that the residuals do not suffer from covariance. Thus we can say that the residuals are independently distributed (that is, i.i.d).

Though they are dubious for models with lagged dependent variables, the DW stats from the FIML estimates in TSP suggest that there is no AR. Table 5.4.3 shows the Correlogram test with lag length 7 confirms that almost all equations are free of AR and ARCH in our dynamic with symmetry version of safety first model 6. Moreover, the normality of the return (profit) has been discussed in chapter four.

Table 5.4.3: Correlogram Test at lag 7

GOVTS	Q-Stat	1.103	1.605	3.648	4.231	4.277	6.319	7.751
	Prob	[0.294]	[0.448]	[0.302]	[0.376]	[0.510]	[0.388]	[0.355]
PUBS	Q-Stat	1.019	1.124	1.421	3.514	4.870	4.870	6.543
	Prob	[0.313]	[0.570]	[0.701]	[0.476]	[0.432]	[0.561]	[0.478]
PRIVS	Q-Stat	0.610	0.611	0.651	1.449	1.495	2.308	2.310
	Prob	[0.435]	[0.737]	[0.885]	[0.836]	[0.914]	[0.889]	[0.941]
PERS	Q-Stat	3.052	4.962	9.508	14.553	14.553	16.222	16.698
	Prob	[0.081]	[0.084]	[0.023]	[0.006]	[0.012]	[0.013]	[0.019]
OTHERS	Q-Stat	0.064	0.080	0.155	3.411	3.524	3.603	3.695
	Prob	[0.801]	[0.961]	[0.985]	[0.492]	[0.620]	[0.730]	[0.814]
TRUST	Q-Stat	5.836	7.205	7.222	7.224	7.823	8.539	9.467
	Prob	[0.016]	[0.027]	[0.065]	[0.125]	[0.166]	[0.201]	[0.221]
SUMB	Q-Stat	26.472	32.882	34.065	34.080	34.080	34.456	34.826
	Prob	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
FGS	Q-Stat	0.004	0.039	0.243	0.297	0.567	0.770	0.822
	Prob	[0.953]	[0.981]	[0.970]	[0.990]	[0.989]	[0.993]	[0.997]
TBILLS	Q-Stat	0.359	0.460	0.595	0.598	0.659	9.373	10.774
	Prob	[0.549]	[0.795]	[0.898]	[0.963]	[0.985]	[0.154]	[0.149]

Moreover, our best safety first dynamic unrestricted model 6 is also stable. As discussed earlier that the characteristics roots of Z should lie between zero and unity. The dynamic system equation (4.23) would be stable if dominant root of the characteristic equation lies inside the complex unit circle. For the computed characteristic roots reported in Table (5.4.4), it can be seen that this condition is satisfied for the estimated Z as the absolute value of all eigen values of Z of each variable is less than 1.

Table 5.4.4: Eigenvalues of the System's Dynamic Matrix

0.772597 + 0.176615i
0.772597 - 0.176615i
0.788413
0.697971 + 0.315665i
0.697971 - 0.315665i
0.455681 + 0.357562i
0.455681 + 0.357562i
0.307269
0.245821

Where as *i* is the imaginary number. So the multiplier effects will have a cyclical path for most of the variables.

5.4.1: Return on the Interest rate Matrix:

The estimated co-efficient are shown in below table and no constant term is included in the estimation. Given the aggregation condition implied from the balance sheet constraint, we have dropped cash equation from the system of demand equations. To obtain the response matrix of interest rate, we have used the Cournot aggregation condition to drive the co-efficient for cash equation, since that condition must hold by definition.

5.4.2: Results on the Own-rate Effects:

It is observed that the performance of our dynamic symmetry model is disappointing. Seven out of ten own-rates bear the correct sign; these are Fgs, Tbills, Cash holdings, lending to the Personal, Public, Trust and Private sectors. The other three co-efficents are wrongly signed; these are Sumb, lending to the Govt and Others sectors.

Among the own rate, in table 5.4.5, four out of ten co-efficients are significant on the basis of asymptotic t-ratios. Whereas out of four significant own rates three coefficents have correct signs i.e g_{i3}, g_{i7} and g_{i8}. It is also noticeable that almost all of the own interest rates have comparatively big numbers that indicate the responsiveness of the choice assets to the changes in their own interest rates.

5.4.3: Results on the Cross-rate Effects:

In table 5.4.5, with regard to off-diagonal rate of return's co-efficients, the result shows that sixteen out of hundred co-efficients in the yields' matrix are significantly different from zero. Some of the composite interest rates are significant; these are Sumb, Tbills and Privs sector. This indicates, similar to E-U model, that interest rates have no effects on decision of allocating the available funds between the choice assets.

Table 5.4.5: Safety First Dynamic Model with Symmetry Restrictions (Estimated impact response: rate of return variables)

EQUNS	*gi1*	*gi2*	*gi3*	*gi4*	*gi5*	*gi6*	*gi7*	*gi8*	*gi9*	*gi10*	*gi*
GOVTS	-27.32	246.16	-231.69	-48.47	3.7	-13.14	336.09	67.08	-334.37	-47.58	2478.4
	[-0.28]	[2.68]*	[-0.92]	[-0.95]	[0.19]	[-2]**	[0.82]	[1.02]	[-1.10]	[-1.4]	[0.81]
PUBS	246.2	195.39	-616.81	-143.66	-14.23	18.69	980.19	28.75	-785.03	32.72	6975.6
	[2.7]*	[0.64]	[-0.98]	[-1.7]***	[-0.37]	[1.18]	[1.24]	[0.25]	[-1.39]	[1.10]	[1.04]
PRIVS	-231.7	-616.81	1960.46	236.24	125.03	-17.02	-3258.89	-389.47	2554.02	-76.03	-27077
	[-0.92]	[-0.98]	[1.94]***	[1.17]	[1.19]	[-0.34]	[-3.44]*	[-1.8]***	[3.21]*	[-1.3]	[-5.48]*
PERS	-48.47	-143.66	236.24	45.8	-50.89	3.71	-89.09	-65.42	131.73	5.66	-685.35
	[-0.95]	[-1.7]***	[1.17]	[0.81]	[-3.63]*	[1.00]	[-0.27]	[-1.12]	[0.54]	[0.24]	[-0.26]
OTHERS	3.7	-14.23	125.03	-50.89	-29.44	0.4	-55.24	19.12	1.82	15.09	572.88
	[0.19]	[-0.37]	[1.19]	[-3.63]*	[-2.5]**	[0.11]	[-0.33]	[0.91]	[0.01]	[2.8]*	[0.48]
TRUST	-13.14	18.69	-17.02	3.71	0.4	5.47	22.47	3.2	-18.86	-1.26	772.49
	[-1.98]	[1.18]	[-0.34]	[1.00]	[0.11]	[1.19]	[0.28]	[0.46]	[-0.32]	[-0.8]	[0.81]
SUMB	-336.1	-980.19	3258.89	89.09	55.24	-22.47	-5744.75	-362.98	4093.15	17.23	-42908
	[0.82]	[1.24]	[-3.44]*	[-0.27]	[-0.33]	[0.28]	[2.35]**	[0.95]	[-1.9]***	[-0.4]	[3.56]*
FGS	67.08	28.75	-389.47	-65.42	19.12	3.2	362.98	258.77	-205.07	20.41	3209.5
	[1.02]	[0.25]	[-1.8]***	[-1.12]	[0.91]	[0.46]	[0.95]	[2.28]**	[-0.62]	[0.69]	[1.17]
TBILLS	-334.4	-785.03	2554.02	131.73	1.82	-18.86	-4093.15	-205.07	2900.55	-17.11	-31094
	[-1.10]	[-1.39]	[3.21]*	[0.54]	[0.01]	[-0.32]	[-1.9]***	[-0.62]	[1.51]	[-0.3]	[-2.50]*
CASH	674.15	2050.93	-6879.65	-198.13	-110.75	40.02	11539.39	646.02	-8337.94		
	[NA]	[NA]	[NA]	[NA]	[NA]	[NA]	[NA]	[NA]	[NA]	[NA]	

*: Significant at 1% level. **: Significant at 5%level. ***: Significant at 10% level. NA: not available

Those coefficients taken at their face the value, however, cannot be very informative about the impact of the net returns on the portfolio composition, because of the non-linearity of the demand equations. It is the slopes of the demand equations, and more especially, the resultant “efor” elasticities that can do so; and the former and latter are listed in Table 5.4.6 & 5.4.7. Of course, we cannot attach any statistical significance to these, since they are affected by all of the coefficients in Tables 5.4.5.

5.4.6: Slopes for Efors of Safety First Dynamic Model with Symmetry Restrictions

EQUNS	*eforgovts*	*eforpubs*	*eforprivs*	*eforpers*	*eforothers*	*efortrust*	*eforsumb*	*eforfgs*	*efortbills*	*eforcash*
GOVTS	0.00043	-0.00292	0.00208	0.0006	-0.00003	0.00019	-0.0029	-0.00075	0.00327	0.00061
PUBS	-0.00252	-0.00071	0.00096	0.00166	0.00033	-0.00004	-0.00155	0.00046	0.00209	-0.00042
PRIVS	0.00009	-0.0002	0.00631	-0.00223	-0.00227	-0.00068	-0.00805	0.00126	0.00332	0.00097
PERS	0.00052	0.00156	-0.00194	-0.00056	0.00063	-0.00008	-0.00058	0.00071	-0.00044	-0.00007
OTHER	-0.00012	-0.00003	-0.0008	0.00067	0.00036	-0.00003	-0.00057	-0.00034	0.0009	-0.00019
TRUST	0.00018	-0.00022	0.00015	-0.00005	0	-0.00007	-0.00018	-0.00003	0.00016	0.00002
SUMB	-0.0007	-0.00241	0.00237	0.00015	0.00154	0.00084	-0.01119	0.00002	0.00727	0.00022
FGS	-0.00051	0.00062	0.00114	0.00074	-0.00016	0.00007	0.00145	-0.00286	-0.00179	-0.00026
TBILLS	0.00144	0.00205	-0.00166	-0.0009	-0.00068	-0.00064	0.00321	-0.00106	-0.00153	0.00022
CASH	0.00084	0.00024	-0.00158	-0.00014	-0.00014	0.00009	0.00427	0.00004	-0.00271	NA

Below table of *efors* elasticites shows that the most sensitive asset to the changes in the *efors* is other sector, which is relatively sensitive to the changes in *eforpubs*, *efortbills* and *eforprivs*.

5.4.7: Elasticities for Efors of Safety First Dynamic Model with Symmetry Restrictions

EQUNS	*eforgovts*	*eforpubs*	*eforprivs*	*eforpers*	*eforothers*	*efortrust*	*eforsumb*	*eforfgs*	*efortbills*	*eforcash*
GOVTS	0.05366	0.04983	0.24204	-0.3204	-0.00271	0.02176	-0.16978	-0.0465	0.223328	-0.0513
PUBS	-0.27121	0.11989	0.09625	-0.0676	0.026866	-0.004	-0.07856	0.02425	0.123698	0.03049
PRIVS	0.00126	-0.0205	0.08093	-0.0024	-0.02359	-0.0084	-0.05196	0.0086	0.025062	-0.009
PERS	0.05625	-0.0403	-0.1954	0.14805	0.05139	-0.0076	-0.02928	0.03788	-0.02623	0.00529
OTHERS	-0.33034	1.22562	-2.0244	-0.0608	0.743766	-0.0692	-0.03331	-0.4595	1.348016	0.35611
TRUST	0.62353	-0.1176	0.49895	-0.6968	-0.00995	-0.2197	-0.30124	-0.0582	0.319944	-0.039
SUMB	-0.02919	0.00402	0.09202	-0.0883	0.048599	0.03141	-0.21882	0.00037	0.166143	-0.0062
FGS	-0.02772	0.02708	0.05817	0.02998	-0.00677	0.0034	0.037229	-0.0774	-0.05363	0.00965
TBILLS	0.10965	-0.0459	-0.1176	0.13754	-0.03925	-0.0443	0.114826	-0.0398	-0.06401	-0.0112
CASH	0.04566	-0.005	-0.0798	0.01137	-0.00571	0.00435	0.108526	0.00111	-0.08051	[NA]

What conclusions can be extracted from those tables? The most important conclusion is that we can identify “unique”, or two-way, complementarity or substitutability, between the endogenous ratios. Such relationships are summarised in Table 5.4.7.1.

We can ascribe economic interpretations to these relationships, which fit in with the risk-return characteristics of the demand equations. Consider for example, the two safest assets in the portfolio, ignoring cash: Federal Government Securities and Treasury Bills. As would be expected, other things being equal, they are substitutes. For given, almost identical, low, risk on each, as the return on the one increases, the other remaining fixed, it is purchased by a switch from the other security. Consider an increase in the return on Federal Government Securities and the supply of loans and the borrowing ratio. In regard to the provision of loans, as the holdings of securities increase, they produce a reduction in the holdings of Government Sector Loans, and those to Other Sectors. The former are probably more lucrative, though riskier, than securities, in that they are probably viewed as more difficult to offload, as perhaps are Other Sector Loans, which are to a more diverse group of borrowers. The increase in the apportionment of the portfolio to loans to the Public, Private and Personal, Sectors, will suggest that these offer higher return per unit of risk than do securities; so that to maintain the required balance between the risk-return characteristics of the portfolio, their holdings are increased, pari passim, with the increased holding of government securities. Finally, the increase in the return on securities that has prompted their increased share in the portfolio would be expected to increase the borrowing from the central bank, at the expense of some of the loans in the portfolio, since that would provide funds for investing in securities.

Table 5.4.7.1: Complementarity and substitutability across the asset ratios

Ratio	*Complements (Y) and Substitutes (X)*									
	Govts	*Pubs*	*Privs*	*Pers*	*Others*	*Trust*	*Sumb*	*Fgs*	*TBills*	*Cash*
Govts			Y		X	Y	X	X	Y	
Pubs					Y			Y		
Privs				X	X			Y		
Pers		X	X			X	X	Y		
Others	X		X			X		X		
Trust	Y	X		X	X					
Sumb	X			X		Y		Y		
Fgs	X	Y	Y	Y	X		Y		X	
TBills	Y						Y	X		
Cash			X	Y				Y	X	

5.4.8: Rate of Return Elasticities of Safety First Dynamic Model with Symmetry Restrictions

EQUNS	*WAG*	*WAP*	*WAPR*	*WAPL*	*WOAH*	*WAT*	*CMR*	*GBYLD*	*SIXMTBR*	*INFL*
GOVTS	11.2	-1.8	2.4	10	-197.5	26.7	-2.4	-9.2	2	2302
PUBS	-2.2	-8.5	6.1	4.2	19.9	-144	-5.3	17.7	3.7	-3872
PRIVS	479.7	-243	7.2	-24.4	-22.6	-69	-8	49.9	18.1	13072.8
PERS	10.7	3.9	-3	-12.4	10.4	-76	-14.1	11.3	-17.3	-22331
OTHERS	-1.8	-9.4	-0.3	0.4	0.7	-8.4	-12.4	-0.9	0.3	-331.5
TRUST	1	-0.8	1.2	-4.3	-53.7	-2.6	-1.4	-7.4	1.4	3030.2
SUMB	-20.7	-6.5	6.4	124.4	11	18.5	-1.9	1167.8	2.7	18888.8
FGS	-21.8	19.1	10.1	18.5	-78.9	170.9	11.1	-5.5	-8.5	-12227
TBILLS	5.5	4.2	-5	-10.9	-13.6	-13.1	3.6	-10.8	-7.1	10524.9
CASH	13.2	50.3	-7.3	-100.8	-93.5	133.5	3.8	387.8	-5.6	[NA]

As per the above table of rate of return elasticities, almost all choice assets are sensitive to the changes in the interest rates. Where as other sector is insensitive to the changes in the interest rates of gbyld, waoh, wapl, sixmtbr and wapr. On the other hand, Trust sector is insensitive to the changes in the interest rates of wag and wap.

There is one further aspect of the impact of the returns on the shares in the portfolio then we can extract from the estimates that related to the “cost of capital” element in the net returns. The slopes and elasticities of the demand equations with respect to component of the net returns are given in Table 5.4.9.

5.4.9: Slopes & Elasticities for CN of Safety First Dynamic Model with Symmetry Restrictions

EQUNS	*CN Slope*	*CN Elasticity*
GOVTS	-0.00057	0.135408
PUBS	-0.00025	-0.019119
PRIVS	0.001457	0.014003
PERS	0.000252	0.019
OTHERS	0.00014	0.267331
TRUST	5.17E-05	0.129043
SUMB	0.001901	0.055354
FGS	0.001555	0.059464
TBILLS	-0.00045	-0.024218
CASH	-0.00091	-0.034602

Above table shows that all choice assets are insensitive to the changes in the *Cn* (d_1/d_2).The greatest impact among all choice assets is on Other sector generated by *Cn*. The data in Table 5.4.9 match obvious a priori expectation. A ceteris paribus increase in the cost of capital increases the ratio of the main earning assets, with the exception of Public Sector Loans. The cost, obviously, is a reduction in liquidity, as Treasury Bills and Cash holdings are reduced; but to provide a correct balance between return and risk, the ratio of Government Securities (with their higher return that Treasury Bills) is increased (for example, as some kind of yardstick, the ratios of the mean net returns on the securities and Treasury Bills are, respectively, 1.44 and 1.36).

5.4.4: Results on the System's Dynamic Matrix:

From the table (5.4.10), we find that out of one hundred co-efficients on the lagged endogenous variables thirty-seven are significantly different from zero. It is also noticeable that all assets do respond to own disequilibrium. Further, some observations can be made on the structure of the system is dynamic matrix,

5.4.10: Safety First Dynamic Model with Symmetry Restrictions (Estimated system's Dynamic Matrix Z)

EQUNS	*GOVTS_1*	*PUBS_1*	*PRIVS_1*	*PERS_1*	*OTHERS_1*	*TRUST_1*	*SUMB_1*	*FGS_1*	*TBILLS_1*	*CASH_1*	*R^2*	*D-W*
GOVTS	0.617	-0.204	0.226	-0.252	1.708	-1.109	0.31	0.123	-0.025	-0.207	0.49	2.42
	[4.780]*	[-1.6]***	[3.58]*	[-1.380]	[1.95]***	[-0.871]	[-3.04]*	[1.590]	[-0.511]	[-1.490]		
PUBS	0.442	0.743	-0.038	0.399	-0.757	2.419	-0.067	0.054	0.063	-0.192	0.77	2.68
	[4.21]*	[7.57]*	[-0.713]	[2.84]*	[-1.097]	[2.25]**	[0.842]	[0.914]	[1.597]	[-1.8]**		
PRIVS	0.185	0.492	0.848	0.084	-0.632	-2.888	0.264	-0.082	0.103	-0.119	0.75	2.15
	[0.745]	[2.18]**	[7.26]*	[0.253]	[-0.379]	[-1.271]	[-1.382]	[-0.570]	[1.083]	[-0.474]		
PERS	-0.182	-0.045	0.071	0.435	0.986	-0.819	0.027	0.002	0.0002	0.112	0.55	2.30
	[-2.41]**	[-0.635]	[1.95]***	[4.35]*	[1.85]***	[-1.051]	[-0.467]	[0.039]	[0.009]	[1.408]		
OTHERS	0.057	0.002	0.006	0.028	0.497	0.526	0.034	0.029	-0.009	-0.058	0.74	1.84
	[3.42]*	[0.123]	[.649]	[1.191]	[4.41]*	[2.93]*	[-2.71]*	[2.89]*	[-1.306]	[-3.42]*		
TRUST	0.011	0.009	-0.004	0.008	-0.06	0.858	0.001	-0.001	0.005	0.007	0.93	1.63
	[1.97]***	[2.01]*	[-1.300]	[1.217]	[-1.9]***	[17.53]*	[-0.325]	[-0.262]	[2.26]**	[1.392]		
SUMB	-0.536	-0.305	-0.515	0.27	0.208	1.143	0.173	-0.153	-0.078	0.132	0.71	2.40
	[2.77]*	[1.77]***	[5.48]*	[-1.059]	[-0.164]	[-0.683]	[-1.19]	[1.422]	[1.027]	[-0.712]		
FGS	0.151	-0.095	0.073	-0.286	0.016	1.298	-0.077	0.734	0.06	0.016	0.78	2.23
	[1.356]	[-0.920]	[1.353]	[-1.855]	[0.020]	[1.131]	[0.872]	[11.31]*	[1.432]	[0.140]		
TBILLS	0.161	0.346	-0.288	0.452	-2.659	-0.326	0.08	-0.18	0.609	0.629	0.82	2.12
	[0.870]	[2.08]**	[-3.06]*	[1.80]***	[-2.19]**	[-0.187]	[-0.546]	[-1.625[	[7.89]*	[3.27]*		
CASH	-0.906	-0.943	-0.379	-1.138	0.693	-1.102	-0.745	-0.526	-0.7282	-0.32	[NA]	[NA]
	[NA]	[NA]	[NA]	[NA]	[NA]	[NA]	[NA]	[NA]	[NA]	[NA]		

*: Significant at 1% level. **: Significant at 5%level. ***: Significant at 10% level. NA: not available because is not estimated directly.

- The largest (in absolute value) off-diagnal elements of the dynamic matrix are found in row relating to cash holdings and Tbills. The column relating to lagged quantities of these two instruments are much smaller in absolute value magnitudes. This suggest that changes in the lagged assets structure strongly effect Tbills and Cash holdings, but changes in these instruments have only small impact on other assets portfolios. Similarly, changes in the assets structure generate strong pressure on Tbills and cash holding, but these asset transfer very little of this pressure back into the rest of the portfolio, which is consistent with the view that Tbills and Cash holding as buffering function in asset structure.
- The magnitudes in the columns relating to lagged quantities of loans to Other sector and Trust sector substantially exceed magnitudes in the rows associated with their current

stocks. This suggest that changes in these items transmit substantial adjustment pressure to the remaining items in the portfolio but they, in turn, absorb very little pressure from other changes in the portfolio.

As discussed earlier in section 4.2, dynamic matrix *Z= I-L,* where as *L (L=I-Z*) is the speed of adjustment matrix which is the "true" adjustment costs .Table 5.4.11 shows the estimated value of matrix *L* for illustration.

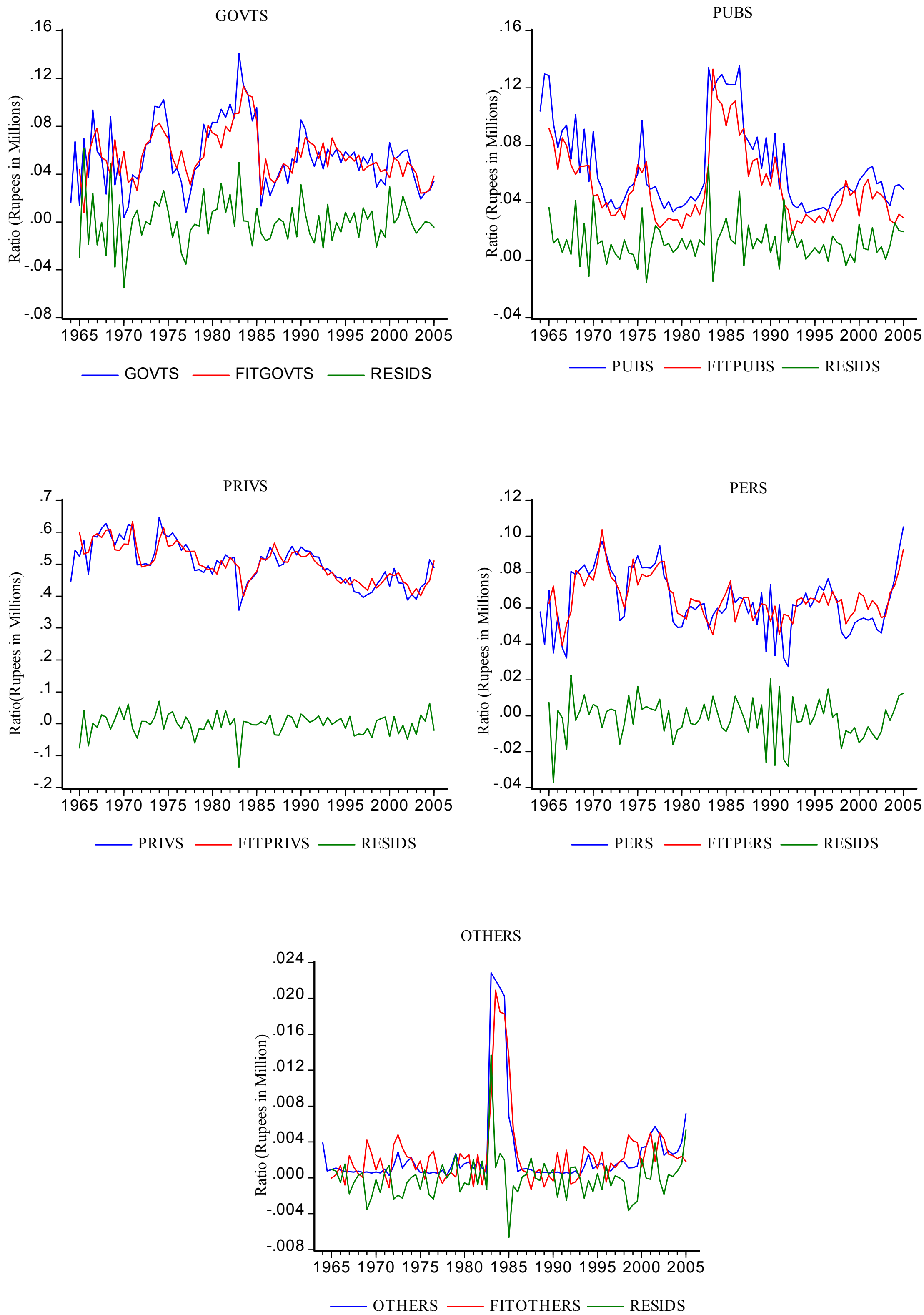
Table5.4.11: L –Matrix for "True" Adjustment Costs

EQUNS	*GOVTS_1*	*PUBS_1*	*PRIVS_1*	*PERS_1*	*OTHERS_1*	*TRUST_1*	*SUMB_1*	*FGS_1*	*TBILLS_1*	*CASH_1*
GOVTS	0.383	0.204	-0.226	0.252	-1.708	1.109	-0.31	-0.123	0.025	0.207
PUBS	-0.442	0.257	0.038	-0.399	0.757	-2.419	0.067	-0.054	-0.063	0.192
PRIVS	-0.185	-0.492	0.152	-0.084	0.632	2.888	-0.264	0.082	-0.103	0.119
PERS	0.182	0.045	-0.071	0.565	-0.986	0.819	-0.027	-0.002	-0.0002	-0.112
OTHERS	-0.057	-0.002	-0.006	-0.028	0.503	-0.526	-0.034	-0.029	0.009	0.058
TRUST	-0.011	-0.009	0.004	-0.008	0.06	0.142	-0.001	0.001	-0.005	-0.007
SUMB	0.536	0.305	0.515	-0.27	-0.208	-1.143	0.827	0.153	0.078	-0.132
FGS	-0.151	0.095	-0.073	0.286	-0.016	-1.298	0.077	0.266	-0.06	-0.016
TBILLS	-0.161	-0.346	0.288	-0.452	2.659	0.326	-0.08	0.18	0.391	-0.629
CASH	0.906	0.943	0.379	1.138	-0.693	1.102	0.745	0.526	0.7282	1.32

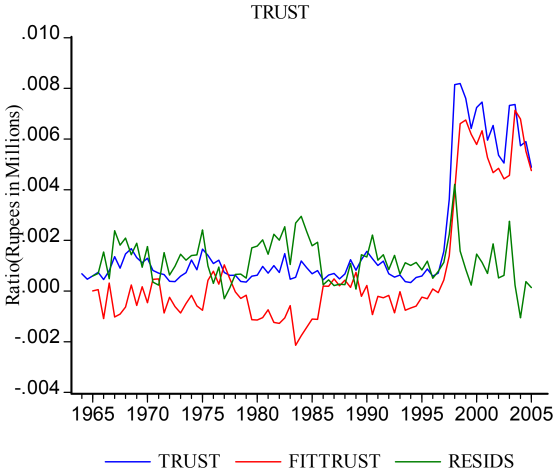
4.4.5: The Overall Evaluation of the dynamic Model: Explanatory Performance:

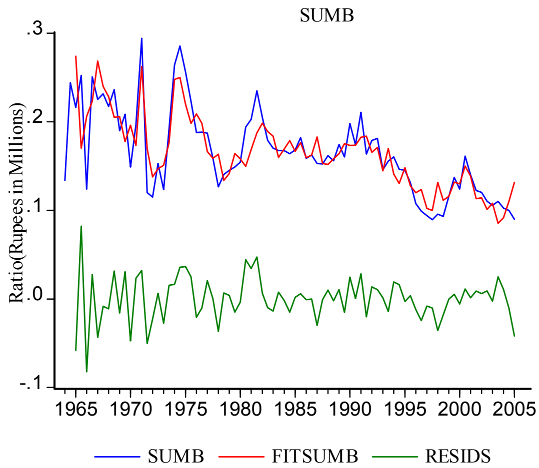
This section is relates to the estimated equations and their properties of residuals. We are going to present the fitted values and actual values of the estimated equations for all endogenous variables for the whole sample period (1964:2-2005:1) indicate that most of the variables, have no divergence between actual and fitted values *(See Figures 5.3.3)*

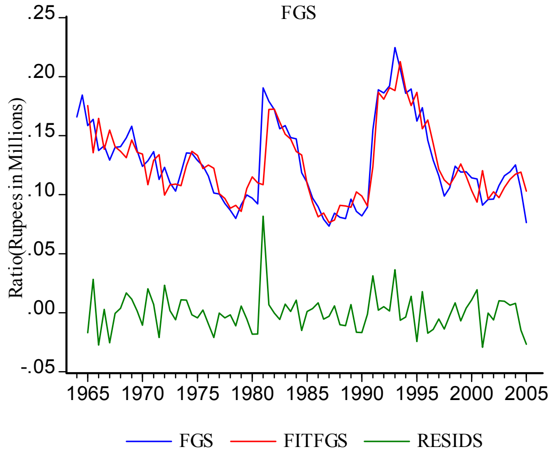
Figures 5.3.3: Actual and Fitted Value (with Residual)

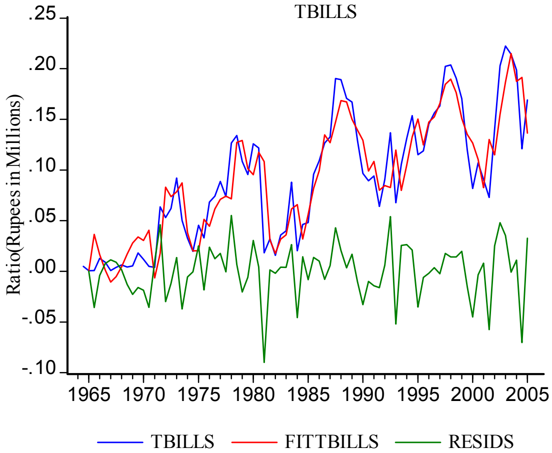


Actual and Fitted Value (with Residual): Continued









5.5: The Aggregation of Loans: A Comparison Between The Best Disaggregated And Aggregated Model.

In the aggregated model, as noted in chapter four, we have aggregated all loans and used the notation for aggregated loans in the table is "Loan" which is summation of Govt, Pubs, Pers, Privs, Othres and Trust sectors loans and remaining items are as it is. Similar to the chapter four, we also want see here if there is a loss of information in explaining the items in the portfolio, and hence the total portfolio, in aggregating all loans, implying that they are perfect substitutes for the banks. We have estimated various dynamic aggregated safety first models. These are: aggregated dynamic unrestricted model, aggregated dynamic restricted model with symmetry, and fully restricted aggregated dynamic model with symmetry and *Gi.* The analysis of models is given in table 5.5.1.

5.5.1: Analysis of Aggregated Safety First Models

Models	*Log-likelihood*	*Restrictions*	*LR-Test*	*Results*
Model 1	822.125	*Unrestricted*		*Accepted*
Model 2	812.438	*Symmetry*	$19.37 > \chi^2_{(6,0.05)} = 12.59$	*Rejected*
Model 3	782.438	*Symmetry & Sum Gi*	$79.39 > \chi^2_{(10,0.05)} = 18.30$	*Rejected*

Model 1: Unrestricted Dynamic Model; **Model 2**: Restricted Dynamic Model with Symmetry; **Model 3**: Fully Restricted Dynamic Model with Symmetry & *Gi* restrictions

We find aggregated unrestricted safety first dynamic model wins in Table 5.5.1 and this dynamic model is stable as well. It can be seen from Table 5.5.2 that all eigenvalues are less than 1 in absolute value

5.5.2:Eigenvalues of the System's Dynamic Matrix *Z*= (*I-L*)

0.926011
0.784652
0.365711
-0.109684
-5.46E-16

We have already presented tables and explained the best disaggregated model in previous section, we also present results for the aggregated model in table 5.5.3, which shows that the behaviour of the safety first (aggregated) unrestricted model is similar to the disaggregated model. Here, the best equations in terms of significance are Loans and FGS.

Table 5.5.3: Safety First (Aggregated) Unrestricted Dynamic Model

	gi1	*gi2*	*gi3*	*gi4*	*gi5*	*gi*	*LOANS_1*	*SUMB_1*	*FGS_1*	*TBILLS_1*	*CASH_1*	*R^2*	*D-W*
LOANS	0.16719	-0.1529	-0.3005	0.18412	-0.1997	-0.8880	0.91281	-0.48744	-0.09502	-0.21306	-0.20812	0.75	2.29
	[1.98]*	[-0.96]	[-2.2]**	[1.05]	[-2.6]*	[-2.63]*	[7.74]*	[-2.28]**	[-0.57]	[-1.74]***	[-0.72]		
SUMB	0.02111	-0.0126	-0.0464	0.02924	-0.0333	0.96277	0.17902	0.19476	-0.06416	-0.15117	-0.06271	0.55	2.06
	[1.01]	[-0.30]	[-1.33]	[0.66]	[-1.37]	[1.27]	[2.99]*	[1.33]	[-0.60]	[-2.07]**	[-0.30]		
FGS	0.07097	-0.0883	-0.1245	0.09699	-0.0884	1.51838	-0.11656	0.21280	0.72925	-0.01303	-0.06083	0.78	1.95
	[2.79]*	[-1.20]	[-3.22]*	[1.22]	[-4.57]*	[3.31]*	[-3.18]*	[2.68]*	[12.06]*	[-0.33]	[-0.58]		
TBILLS	0.07405	-0.1000	-0.1099	0.08645	-0.0693	-1.0384	-0.07639	-0.11973	-0.05970	0.66733	0.35418	0.82	1.95
	[1.29]	[-1.17]	[-1.18]	[1.00]	[-1.24]	[-1.26]	[-0.92]	[-0.87]	[-0.53]	[7.82]*	[1.93]***		
CASH	-0.33332	0.35397	0.58143	-0.39680	0.39085		-0.89889	0.19961	-0.51037	-0.29008	-0.02253	[NA]	[NA]
	[NA]	[NA]	[NA]	[NA]	[NA]	[NA]	[NA]	[NA]	[NA]	[NA]	[NA]		

*: Significant at 1% level. **: Significant at 5%level. ***: Significant at 10% level. NA: not available because is not estimated directly.

To see the comparison between safety first disaggregated and aggregated models, we plot different forecasting and other statistics below.

Table 5.5.4: Safety First Disaggregated forecasting table (1964:2 to 2005:1)

EQNS	*RMSE*	*MAE*	*MAPE*	*Thiel I Coeff*	*Bias Prop*	*Var Prop*	*Cov Prop*	*R^2*
LOANS	0.034847	0.026252	3.792178	0.025093	0.002055	0.068162	0.929783	*0.81*
GOVT	0.019185	0.014021	52.35086	0.159681	0.000167	0.146317	0.853516	*0.49*
PUBS	0.014815	0.010748	17.05652	0.10765	0.024904	0.006822	0.968274	*0.77*
PRIVS	0.032531	0.024226	4.974609	0.032093	0.000008	0.086566	0.913426	*0.75*
PERS	0.011215	0.008678	16.34723	0.084846	0.000158	0.210047	0.789795	*0.55*
OTHES	0.002343	0.001484	123.5613	0.236241	0.000056	0.073537	0.926407	*0.74*
TRUST	0.001451	0.001202	128.9436	0.255371	0.629418	0.02327	0.347312	*0.88*
SUMB	0.025256	0.018596	11.64175	0.073884	0.000072	0.065395	0.934534	*0.71*
FGS	0.016208	0.0114	9.287103	0.062359	0.000144	0.040473	0.959383	*0.78*
TBILLS	0.026544	0.0198	122.484	0.121164	0.000031	0.045824	0.954145	*0.82*

Table 5.5.5: Safety First Aggregated forecasting table (1964:2 to 2005:1)

EQNS	*RMSE*	*MAE*	*MAPE*	*Thiel I Coeff*	*Bias Prop*	*Var Prop*	*Cov Prop*	*R^2*
LOANS	0.042494	0.031484	4.445572	0.029971	0	0.072747	0.927253	*0.75*
SUMB	0.031606	0.023143	14.77807	0.09275	0	0.148887	0.851113	*0.55*
FGS	0.015796	0.011721	9.553852	0.060763	0	0.05944	0.94056	*0.78*
TBILLS	0.026476	0.020591	107.2862	0.120852	0	0.049411	0.950589	*0.82*

Table 5.5.6: Safety First Disaggregated forecasting table (1964:2 to 2008:1)

EQNS	*RMSE*	*MAE*	*MAPE*	*Theil I Coeff*	*Bias Prop*	*Var Prop*	*Cov Prop*	*R^2*
LOANS	0.042711	0.029865	4.34059	0.030808	0.000513	0.005746	0.993741	*0.70*
GOVT	0.019191	0.014023	51.90505	0.160357	0.001298	0.152554	0.846148	*0.50*
PUBS	0.015518	0.011118	17.61977	0.116674	0.174706	0.002697	0.822598	*0.32*
PRIVS	0.032797	0.024697	5.031115	0.032489	0.015266	0.093443	0.891291	*0.41*
PERS	0.011267	0.008648	16.60881	0.084548	0.011497	0.193091	0.795413	*0.64*
OTHES	0.002684	0.00148	94.184	0.311692	0.073565	0.417556	0.508879	*0.33*
TRUS	0.001691	0.001329	119.9317	0.292606	0.504007	0.009459	0.486533	*0.46*
SUMB	0.026172	0.019835	12.00327	0.078133	0.069062	0.095819	0.835119	*0.52*
FGS	0.016226	0.011426	9.246181	0.062612	0.003329	0.045066	0.951605	*0.76*
TBILLS	0.026544	0.019787	122.6874	0.12106	0	0.0442	0.955799	*0.82*

Table 5.5.7: Safety First Aggregated forecasting table (1964:2 to 2008:1)

EQNS	*RMSE*	*MAE*	*MAPE*	*Thiel I Coeff*	*Bias Prop*	*Var Prop*	*Cov Prop*	*R^2*
LOANS	0.045655	0.033475	4.732788	0.032283	0.000058	0.051007	0.948935	*0.69*
SUMB	0.036543	0.026072	17.54427	0.109897	0.000602	0.117143	0.882254	*0.42*
FGS	0.016033	0.011843	10.87237	0.063558	0.0008	0.103435	0.895765	*0.82*
TBILLS	0.032044	0.023132	102.967	0.142128	0.003561	0.029577	0.966862	*0.74*

Above forecasting statistics show that almost all equations with forecasting point of views are best except (a) Govt, Others, Trust and Tbills in disaggregated model for 1964:1 2005:1,(b) Tbills for aggregated model for 1964:1 2005:1, (c) Govt, Others, Trust and Tbills in disaggregated model for 1964:1 2008:1 and (d) Tbills in aggregated model for 1964:1 2008:1 (c), as they have very high percentage of MAPE. Further, if you compare the forecasting statistics for disaggregated and aggregated models for the same period, we find there is no big difference among similar equations.

On the other hand, R squared values tell us the disaggregated model wins aggregated model for the in-sample period 1964:1 2005:1. Disaggregated model explains Loans better (0.81 against 0.75); Sumb better (0.71 against 0.55); and FGS, Tbills have same values (0.78 & 0.82 respectively) in both disaggregated and aggregated models. For the whole sample: (a) for Loans,R-squared is 0.70 for the disaggregated model and 0.69 for aggregated model; (b) for sumb, R-squared is 0.52 for disaggregated model and 0.42 for the aggregated model; (c) for FGS, R-squared is 0.76 for disaggregated model and 0.82 for the aggregated model; but, (c) for Tbills, the R-squared is 0.82 for the disaggregated model and 0.74 for the aggregated model.

For the in sample data the disaggregated model is the superior model. For the whole sample, it is better for accounting for the choice of the riskier assets and some of the safer assets. The in-sample findings suggest that the banks separate out the choice of risky versus "safe" assets and then choose across the risky assets: such that those assets are potential competitors, and not the (perfect) substitutes that is implied in aggregated model.

5.6: Summary:

For further investigation to the portfolio behaviour of commercial banks in Pakistan, we have estimated various disaggregated static and dynamic safety first models. We have found that the static unrestricted model is the best model among all potential static models on the basis of Log likelihood values but it has poor quality as R-squared and D-W statistics show that the explanatory variables do not explain most of the dependent variables and they have also suffer from autocorrelation. Therefore, we have chosen the best safety first dynamic model with symmetry restriction to explain the banking portfolio of Pakistan. As this dynamic model wins over all the potential dynamic models in the sense of Log likelihood values and it has high R-squared and good residual properties.

We have also estimated various dynamic aggregated safety first in which we have aggregated all loans i.e Govt, Pubs, Pers, Privs, Others and Trust sectors loans, and remaining items are as it is. The basic idea is to see if there is a loss of information in explaining the items in the portfolio, and hence the total portfolio, in aggregating all loans, implying that they are perfect substitutes for the banks. We have also plotted different forecasting and other statistics to compare the best safety first disaggregated and aggregated models within the sample period and out of the sample period. The comparison shows that the disaggregated model wins over aggregated model.

APPENDIX A

DERIVATION OF THE BANK'S OPTIMAL DEMAND FOR CHOICE ASSETS

In order to minimise the probability of disaster investor has to select the highest slop. For example, If bank chooses the portfolio at the point *P* in figure 1, where the line *DP* touches to the mean-variance curve *AB* that is a tangential to the efficient mean-variance frontier, can be expressed as follows.

(5.1A) $\mu_\pi = D + s\sigma_\pi$

At the optimal portfolio point *P,* the tangent line *DP* and the mean variance curve *AB* must be equal. Thus, substituting μ_π from equation (5.1A) into equation (5.21) gives

(5.2A) $(d\alpha - s^2)\sigma_\pi^2 + 2k(d_1 - D - \beta d_2)\sigma_\pi - [D - (d_1 - \beta d_2)]^2 + (\beta^2 - \gamma)d^2 = 0$

Equation (4.2A) can be written as quadratic function of σ_π^2

(5.3A) $a\sigma_\pi^2 + b\sigma_\pi + c = 0$

Where

$a = d\alpha - s^2$

$b = 2s(d_1 - D - \beta d_2)$

$c = -[D - (d_1 - \beta d_2)]^2 + (\beta^2 - \gamma)d^2 = 0$

There will be in general two solutions for σ_π^2, which can be obtained directly from the standard formula

$$\sigma_\pi = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Since, at the point *P* where line *DP* is tangent to the curve *AB*, it must be the only one of these roots for equation (5.3A) which is required that

$b^2 - 4ac = 0$

Or

$4s^2(d_1 - D - \beta d_2)^2 = 4(d\alpha - s^2)[(\beta^2 - \gamma)d_2^2 - (D - d_1 + \beta d_2)^2]$

From which we deduce the optimal value for s^2 as

(5.4A) $s^2 = d\alpha[1 + \frac{(D - d_1 + \beta d_2)^2}{(\beta^2 - \gamma)d_2^2}]$

Equation (5.1A) shows that the slope of the tangent line *DP* is *s*. At this tangent point, the slop has to be equal to the slop of the efficient mean-variance frontier *AB* which can be found by taking differentiation of equation (5.21) with respect to σ_π, which is

(5.5A) $\frac{\partial \mu_\pi}{\partial \sigma_\pi} = \frac{d\alpha}{\mu_\pi - d_1 + \beta d_2} \sigma_\pi$

Substituting $\sigma_\pi = \frac{\mu_\pi - D}{s}$ from equation (5.1A) into equation (5.5A) to get

(5.6A) $\frac{\partial \mu_\pi}{\partial \sigma_\pi} = \frac{d\alpha}{\mu_\pi - d_1 + \beta d_2} (\frac{\mu_\pi - D}{s})$

These two slopes are equal as

(5.7A) $s = \frac{d\alpha}{\mu_\pi - d_1 + \beta d_2} (\frac{\mu_\pi - D}{s})$

Thus the optimal value of μ_π can be obtained as

(5.8A) $\mu_\pi = \frac{d\alpha D - s^2(d_1 - \beta d_2)}{d\alpha - s^2}$

Substituting s^2 from equation (5.4A) into equation (5.8A), so that

(5.9A) $\mu_\pi = \frac{(\beta^2 - \gamma)d_2^2}{D - d_1 + \beta d_2} + d_1 - \beta d_2$

By putting above value of μ_π in equations (5.18) and (5.19), and using the expression of β from equation (5.23) to get the solution of λ_1,and λ_2, which are not involve μ_π and σ_π, as

(5.10A) $\lambda_1 = -\frac{d_2^2}{i_1^{'}\Omega_{11}^{-1}i_1(\beta d_2 - d_1 + D)} = -\frac{d_2}{[e_1 - (d_1 - D)/d_2 i_1]^{'}\Omega_{11}^{-1}i_1}$

(5.11A) $\lambda_2 = \frac{(D-d_1)d_2}{i_1^{'}\Omega_{11}^{-1}i_1(\beta d_2 - d_1 + D)} = \frac{D-d_1}{[e_1-(d_1-D)/d_2 i_1]^{'}\Omega_{11}^{-1}i_1}$

Substitute solution from equations (5.10A) and (5.11A) into equation (5.13) to yield the bank's optimal asset demand equation:

(5.12A) $\hat{A}_1 = -\frac{\Omega_{11}^{-1}[e_1-(d_1-D)/d_2 i_1]}{[e_1-(d_1-D)/d_2 i_1]'\Omega_{11}^{-1}i_1} d_2$

Which is (5.25) in the main text.

APPENDIX B

B1: Descriptive Statistics of Endogenous Variables (Ratios):

	GOVTS	*PUBS*	*PRIVS*	*PERS*	*OTHES*
Mean	0.05	0.05	0.42	0.05	0
Median	0.04	0.05	0.42	0.05	0
Maximum	0.12	0.11	0.5	0.1	0.02
Minimum	0	0.03	0.3	0.02	0
Std. Dev.	0.02	0.02	0.04	0.01	0
Skewness	0.49	1.05	-0.4	0.05	3.55
Kurtosis	3.33	2.96	3.07	3.31	15.05
Jarque-Bera	3.71	15.26	2.2	0.37	676.97
Probability	0.16	0	0.33	0.83	0

	TRUSTS	*SUMB*	*FGS*	*TBILLS*	*CASH*
Mean	0	0.14	0.11	0.08	0.11
Median	0	0.14	0.1	0.08	0.1
Maximum	0.01	0.22	0.19	0.2	0.15
Minimum	0	0.08	0.06	0	0.08
Std. Dev.	0	0.03	0.03	0.06	0.02
Skewness	1.69	0.3	0.76	0.34	0.54
Kurtosis	4.24	2.53	3.1	2.12	3.01
Jarque-Bera	45.06	2.02	8.08	4.31	3.97
Probability	0	0.36	0.02	0.12	0.14

B2: Descriptive Statistics of Interest Rates (Efors):

	eforgovts	*eforpubs*	*eforprivs*	*eforpers*	*eforothers*
Mean	6.91	6.07	6.44	4.62	5.23
Median	6.84	5.94	6.45	4.15	5.06
Maximum	12.28	9.84	10	10.44	11.61
Minimum	-1.88	-1.6	-1.99	-2.66	-2.53
Std. Dev.	2.12	2.1	2.16	2.59	2.65
Skewness	-0.66	-0.55	-0.84	0.12	0.03
Kurtosis	5.79	3.99	4.78	3.5	3.58
Jarque-Bera	32.85	7.54	20.84	1.05	1.19
Probability	0	0.02	0	0.59	0.55

	efortrusts	*eforsumb*	*eforfgs*	*efortbills*	*eforcash*
Mean	6.23	3.25	3.42	3.79	-4.63
Median	6.04	3.23	3.35	3.73	-5.55
Maximum	11.31	8.89	7.85	10.58	-0.56
Minimum	-2.31	-2.4	-1.75	-2.41	-9.82
Std. Dev.	2.52	2.37	2.37	2.78	2.16
Skewness	-0.23	-0.33	0.01	-0.12	0.27
Kurtosis	3.62	3	2.72	2.81	2.21
Jarque-Bera	2.08	1.49	0.28	0.32	3.21
Probability	0.35	0.47	0.87	0.85	0.2

CHAPTER SIX

CONCLUSION AND COMPARISION BETWEEN EXPECTED UTILITY AND SAFETY FIRST MODELS

In chapter four, the expected utility has empirically described the asset structure adjustment behaviour of commercial banks in Pakistan in the context of a model that explicitly allows for cross effects among instruments. The empirical results provides support for the hypothesis that the structure of interest rates is an important determinant of the composition of the assets' holdings of the commercial banks in Pakistan but it looks that the availability of funds is more important in determining the structure of these portfolios. The result of expected utility model lend to empirical support to the general stock adjustment formulation. It seems that portfolio decision do take account of liquidity and to a lesser extent of profitability attributes of the various assets.

We have included dummy in our expected utility model so as to see the structural break due to the effect of Islamisation process of the financial system in Pakistan that was started in 1979 when the specialized credit institutions in the public sector reoriented their financial activities towards non-interest bearing operations. We found dummies are significant in five out of nine system equations. On January 1st, 1981, all domestic commercial banks were permitted to accept deposits on the basis of profit and loss sharing (PLS), and during the transition phase most banks were allowed to practice traditional banking alongside the Islamic system. Separated interest-free counters started operating in all domestic commercial banks, and one foreign bank (Bank of Oman) began to mobilize deposits on a profit and loss sharing basis. By July 1st, 1985, all commercial banking transaction in rupees were made interest-free and since then no bank in Pakistan, including foreign banks, has been allowed to accept any interest bearing deposits and all existing deposits in a bank have been treated on the basis of PLS. Deposits in current accounts continue to be accepted but no interest or share in profit or loss is allowed. In addition, all finance provided by banks to the government, public or private sectors, joint stock companies is only on basis of the specified Islamic modes of financing.

We wanted to include Non-performing Loans (NPL) and Growth rate as variables to capture explicitly aspects of risk for each type of assets in our model and these have to be treated as exogenous variables, under our theoretical framework. We could not include NPL as a variable in our estimation due to non-availability of data; the only data is available from 2002 to 2004. On the other hand we also employed growth rate in our portfolio model to get the impact of systematic risk or economic risk on the portfolio. In line with impact effects, we would expect the effects of Growth rate to be negative on their corresponding assets holding. We found that the growth rate was significant in only one equation which is lending to the Public sector out of nine equations of the system. The total effects of Growth rate are correct (negative) for Federal Bonds, Treasury Bills, Cash and lending to the Personal, Trust and Private sectors; while in short-run (impact effect) show correct (negative) effect for Treasury Bills, Cash and lending to the Personal, Trust and Private sectors. These results indicate that Growth rate is more effective in affecting bank behaviour in long-run period by having 60% (6 out of 10 possible negative signs) correct signs than for short-run period by having 50% (5 out of 10 possible positive signs) correct signs.

Despite the fact that the results shown in expected utility chapter indicate that a number of coefficients have inappropriate signs and the assumption of non-negativity of the diagonal elements of the rates of return matrix has been violated. Though these results may seem disappointing, they are typical of reported econometric models of banks behaviour (see i.e, Aigner(1973), Humphery(1981), Spindt and Tarhan (1980) and Thistle et al (1989)[1]. On the other hand, the empirical tests of the restrictions to date are not conclusive. The results of testing restrictions implied by the mean variance approach or implied by the balance sheet condition show the rejection of both symmetry and homogeniety. The rejection of these restrictions is common in the literature; it could be mentioned that the power of testing may be reduced since the observation period is rather short (see Keuzenkamp and Barten(1995)).

The level of capital considered one of the key measures of stability of financial system. Higher base capital not only enhances the confidence of the stakeholders but also reduces the moral hazards problem and boosts the competition in the market. For the stability of the banking system, the State Bank of Pakistan has adopted two strategies for strengthening the capital base. On one hand, SBP focuses on the increase in the capital base by enhancing the minimum capital requirement from time to time. On the other hand it enforces risk-base capital requirement in the form of adoption of International standard of capital-Basel 1, initially and setting minimum standard of capital adequacy ratio

[1] See Ford (1994, 2001)

during late 90s. The State Bank of Pakistan has developed a uniform bank rating system in conformity with international standards/benchmarks. Now each bank is appraised under the CAMELS Rating System.

The SBP has to give commercial banks of Pakistan so-called CAMELS rating, which is based on six areas assessed: capital adequacy, asset quality, management, earnings, liquidity, and sensitivity to market risk. With above information, SBP can enforce regulations by taking such formal actions as cease and desist orders to alter the bank's behaviour or may close a bank if its CAMELS rating are very low. These actions are taken to mitigate moral hazard by imposing restrictions to the banks from taking on too much risk. It does also help reducing adverse selection problem because with less opportunity for risk taking, risk-loving entrepreneur will be less likely to be attracted to the banking industry. Additionally, The Banking Companies Ordinance had been amended in 1997, which empowers the State Bank to prescribe capital requirements for banks. In exercise of these powers the State Bank has laid down Minimum Capital Requirements for banks based on Basle capital structure. The banks have to maintain a Capital Adequacy Ratio in a way that their capital and unencumbered general reserves are, at the minimum, 8% of their risk weighted assets, and effective from 1st January, 2003 banks are required to maintain a minimum paid up capital level of Rs.1 Billion. Now implementation of Basel II would also rationales the risk exposures vis –a viz. capital[2].

[2] see- the State Bank of Pakistan web site,Frederic S Mishkin(2003) and Saunders and Cornett(2006)

In continuation, both of these approaches has benefited the financial system in terms of improved stability and resilience, operating efficiencies and also attracted foreign investments in this area. Growing asset base, largely financed by the steady deposit flows signifies the increasing confidence of the depositors on the stability of the banking system. Improved asset quality talks about the improved risk management, credit appraisal and monitoring standards[3]. In the light of above restrictions under Basel 1, Bank has to change its portfolio behaviour according to the Basel 1 accord (minimum capital requirement and risk base capital requirement).

Our expected utility model attempt to reflect the institutional framework of the banking sector of Pakistan, it does not incorporate certain aspects of the system i.e, the effects of changes in reserve requirements, interest rates limits on deposits, and compensatory deposits balances are not considered.

Although interest rates and yields appeared relatively insignificant in expected utility model when compared to other variables such as the availability of funds, they can not be discounted in policies relating to the portfolio of banks in Pakistan. Therefore, according to Ford, Kagigi and Cadle (1999) the role of interest rates in the determination of bank portfolio behaviour in developing countries is unsettled and demands further investigation.

[3] See –State Bank of Pakistan web site.

For further investigation of bank portfolio behaviour of Pakistan, we have estimated the best safety first with symmetry restrictions model in chapter five. In terms of emphasis, safety first model has derived quite similar to those of expected utility maximisation. In both models, the only source of portfolio diversification is the interest rate uncertainty. Symmetry condition does hold in safety first model but not in expected utility model model. Although, there are some similarities in both model, but safety first model is different from expected utility model in many important ways.

The bank demand for the choice asset depends on their expected rates of return with keeping assumption that the rates of return on the choice items are un-correlated. The banks' demand equations are highly non-linear in the expected rates of return. The demand for one choice asset will depend on its own expected rate of return as well as the expected rates of return on all other choice assets, even though the rates of return on the choice items are not correlated with each other. Due to high degree of nonlinearity in the Safety First model, some estimation problems have to face i.e, not only do estimations take longer converge but parameter estimates are also more sensitive to small changes in the data.

Like expected utility, we have included dummy in our safety first model so as to see the structural break due to the effect of Islamisation process of the financial system in Pakistan that was started in 1979 when the specialized credit institutions in the public sector reoriented their financial activities towards non-interest bearing operations. We have found dummies are not significant in our system of equations.

Unlike expected utility model where we have to take the assumption of normal distribution, the safety first model does not depend on any specific assumption about the exact distribution of the actual return on a portfolio or the form of the utility function. Therefore, the safety first models estimated in this chapter are consistent with a wide range of distributions of the rate of return on the portfolio. It is also argued that the safety first models are distribution-free.

The forecasting statistics of both models show that the forecasting behaviour of both models are more or less similar and perform well.

Overall, the safety first dynamic model marginally performs better than expected utility model in terms of co-efficents' significance of interest rates and general stock adjustments. It can be said that the safety first model does explains better the portfolio behaviour of Pakistani Banks. Further search in this area is obviously required.

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